University of Alberta

Animal Production and Consumption in Roman Italy: The Zooarchaeological and Textual Evidence

by

Michael Ross MacKinnon ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Department of Anthropology

Edmonton, Alberta
Fall 1999

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University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **Animal Production and Consumption in Roman Italy: The Zooarchaeological and Textual Evidence** submitted by **Michael Ross MacKinnon** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy**.

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ABSTRACT

This thesis analyzes two sets of data: remains of animal bones recovered from archaeological excavation, and references to animals contained in the ancient Latin texts; and integrates the material to develop a more complete picture of the role of animals in the diet and economy of Roman Italy. The results are subsequently tested within an economic framework, or model, developed by Gillian Clark (1987) which considers characteristics of the faunal and textual record indicative of production and consumption activities.

Faunal materials from 73 Roman period sites in Italy, distributed spatially across the whole country, dated from 500 BC to AD 500, and of varying site type (i.e., rural, urban, special), comprised the zooarchaeological database. Primary data were obtained for four sites, while the remaining data were obtained from published and unpublished reports. This zooarchaeological database was set against a comprehensive listing of over 2,000 ancient textual references pertaining to animals, meat, and related economic and dietary topics, and collected from a wide selection of Latin texts including agricultural manuals, law codes, inscriptions, letters, and various literary genres.

The analysis reveals considerable correlation in terms of evidence for animal husbandry schemes and assists in reconstructing the variation in these coincident with temporal and geographic factors. Both sources highlight the importance of cattle, sheep/goat, and pigs to the Roman economy and diet. They concur that most cattle were kept to older ages and exploited as work animals prior to consumption, but some evidence for ranching and dairying operations is noted, particularly among sites in northern Italy. Sheep largely outnumber goats and a range of shepherding schemes from transhumant herding to stall raising is revealed from combined examination of zooarchaeological and textual materials.

Pigs were raised in varying numbers in both intensive and somewhat relaxed husbandry systems with many males preferentially slaughtered at younger ages.

Combined zooarchaeological and textual analysis also reveals much overlap in the information provided about mammalian consumption. Beef and pork were popularly consumed throughout Roman Italy, but wild animals provided little meat to the diet, especially at urban sites. The skewed distribution of skeletal parts between many rural and urban sites, however, alludes to a much greater degree of meat preservation, trade, and transport of mammalian goods between city and country than what is documented in the ancient texts.

ACKNOWLEDGMENTS

Many individuals have assisted during the course of this thesis study. Foremost, I thank my supervisors, Nancy Lovell and Alastair Small, for their guidance in steering me along a path which linked Anthropology with Classical Studies. Interdisciplinary research can double the number of challenges a student encounters. The advice of my supervisors has helped ease this process.

The support and encouragement of many zooarchaeologists and archaeologists who have contributed data or provided comment is greatly appreciated. In particular I wish to thank Umberto Albarella, Annie Grant, Graeme Barker, Gillian Clark, Tony King, David Soren, David Reese, Terry O'Connor, Neil Christie, Eleanor Scott, Dale Serjeantson, Peter Rowley-Conwy, Paul Arthur, Polydora Baker, Achilles Gautier, Gentry Steele, Robert and Helen Buck, Paul Reynolds, Jonathan Driver, Pam Willoughby, Jeremy Rossiter, Helena Fracchia, Maurizio Gualtieri, Chris Simpson, Naomi Norman, and Henry Hurst.

Friends and family provided the glue which held me together through the thesis process. Special thanks are extended to my parents, Ross and Joanne MacKinnon, for listening and understanding in a patient manner. The support of my friends and graduate student colleagues, Greg Zukiwsky, Margaret Judd, John Plews, Sandy McClellan, Julie Ross, Frances Condron, Alex Smerlas, Laura Lipcsei, Elizabeth Pennefather-O'Brien, Franca Boag, Cidalia Duarte, Brent Roe, Sandra Bingham and Stephen Copp is much appreciated. Their help cannot be expressed in words.

Finally, I would like to acknowledge the financial assistance of the Social Sciences and Humanities Research Council of Canada (Doctoral Fellowship 752-94-1312) and the Izaak Walton Killam Memorial Scholarship (University of Alberta).

CONTENTS

List of Tables

List of Figures

List of Abbreviations

Introduction........1

Chapter 1: The Ancient Texts........7
  Introduction........7
  Biases and Limitations........9
    The Audience........9
    Temporal and Regional Biases........11
    Reliability........14

Chapter 2: Background to Zooarchaeology........19
  Development of Zooarchaeology........19
  Methods of Analysis........21
    Recovery........21
    Taphonomy........21
    Identification........22
    Quantification........23
    Age and Sex........25
    Pathology........27
    Measurements........28
  Topics of Study........28
    Natural........28
      Climate and Environmental Reconstruction........28
      Seasonality........29
    Cultural........30
      Animal Husbandry........30
      Butchery........30
      Dietary Reconstructions........32
      Other Animal Products........32
      Ritual and Sacrifice........33
    Animal Production and Consumption and the Nature of the Archaeological Sample........35

Chapter 3: Modeling Production and Consumption........37
  Introduction........37
  Archaeological Models........37

Economic Complexity: Producer-Consumer Model....38
Production Sites....39
Consumption Sites....40

Chapter 4: Materials and Methods....44
Introduction....44
The Sites....50
Southern Italy....50
Republican....50
Imperial and Late Antiquity....50
Central Italy....50
Republican....51
Imperial....51
Late Antiquity....51
Northern Italy....51
Republican....51
Imperial....52
Late Antiquity....52
The Data....52
Assumptions....52
Data Standardization....53
Recovery of Bone Remains....53
Preservation and Taphonomy....55
Carnivore Gnawing....59
Other Taphonomic Factors....60
Sample Size....61
Identification....63
Quantification....64
NISP Analysis....65
MNI Analysis....66
Cattle, Sheep/Goats, and Pigs....66
Equids....67
Dogs....67
Cats....68
Wild Animals....68
Rodents....68
Production and Consumption....69

Chapter 6: Results: Production....71
Part 1: Cattle....71
Zooarchaeological Data....71
Identification and Quantification....71
Age....72

            Seasonality....73
            Sex....73
            Age and Sex Correlation....75
            Size....76
            Abnormalities....78
        Textual Data....78
        Integration....82
    Part 2: Sheep and Goats....89
        Zooarchaeological Data....89
            Identification and Quantification....89
            Sheep/Goat Distinction....91
            Age....92
            Seasonality....93
            Sex....94
            Age and Sex Correlation....95
            Size....96
            Abnormalities....97
        Textual Data....97
            Sheep....97
            Goats....104
        Integration....105
    Part 3: Pigs....119
        Zooarchaeological Data....119
            Identification and Quantification....119
            Age....121
            Seasonality....123
            Sex....124
            Age and Sex Correlation....124
            Size....125
            Abnormalities....126
        Textual Data....127
        Integration....130

Chapter 6: Discussion: Testing the Modeled Criteria for Production....140

Chapter 7: Results: Consumption....149
    Part 1: Animal Butchery, Meat Preservation, and Cooking....149
        Zooarchaeological Evidence....149
            Butchery....149
                General Butchery....150
                    Cattle....150
                    Sheep and Goats....151
                    Pig....152

Special Butchery....................153
Bisection of Vertebrae....................153
Horn Removal....................154
Butchery in Wild Animals....................154
Butchery Location....................154
Preservation and Storage....................155
Cooking....................155
Textual Evidence....................157
Butchery and Preservation....................157
Butchers....................159
Cooking....................159
Integration....................161
Butchery....................161
Preservation....................172
Cooking....................175
Part 2: Meat in the Roman Diet....................177
Zooarchaeological Evidence....................177
Meat Weight Analysis....................177
Domestic vs. Wild Meat....................179
Domestic Mammals....................182
Body Parts Analysis....................184
Cattle Parts....................185
Sheep/Goat Parts....................189
Pig Parts....................191
Textual Evidence....................195
Roman Meals....................195
Roman Food....................195
Mammals in the Roman Diet....................196
Meat Diet and Social Class....................198
Meat Diet of the Roman Elite....................198
Meat Diet of the Roman Poor....................200
Meat in the Military Diet....................201
Sumptuary Laws....................202
Integration....................203
Mammals in the Roman Diet....................204
Wild Mammals....................204
Domestic Mammals....................208
Body Parts....................212
Meat Diet and Social Class....................221
Meat in the Military Diet....................224
Sumptuary Legislation....................225

Chapter 8: Discussion: Testing the Modeled Criteria for Consumption....................227

Chapter 9: Summary and Conclusions.......233
  Integration of Zooarchaeological and Textual Data about Mammals in Roman Italy.......233
    Production.......237
      Cattle Husbandry.......237
      Sheep/Goat Husbandry.......237
      Pig Husbandry.......238
      Animal Husbandry in General.......238
    Consumption.......239
      Butchery.......239
      Cooking.......239
      Diet.......239
    Principal Limitations of Combined Zooarchaeological and Textual Analyses for Roman Italy.......240
    Linking Sites in Roman Italy on the Basis of Zooarchaeological and Textual Data.......240
  Modeling Production and Consumption of Animals in Roman Italy.......242
    Labeling and Quantifying Production.......242
    Age and Sex Data.......243
    Distinguishing Exchange Mechanisms.......244
    The Cultural Context.......245
  Future Recommendations.......246

Tables.......250

Figures.......324

Bibliography.......345

Appendices.......372

LIST OF TABLES

TABLE 1: Author, work, and approximate date range for ancient texts consulted with relatively many references to animals......250

TABLE 2: Author, work, and approximate date range for ancient texts consulted with relatively few references to animals......251

TABLE 3: Southern Italy: Republican period sites......252

TABLE 4: Southern Italy: Imperial and Late Antiquity sites......253

TABLE 5: Central Italy: Republican period sites......254

TABLE 6: Central Italy: Imperial period sites......255

TABLE 7: Central Italy: Late Antiquity sites......256

TABLE 8: Northern Italy: Republican period sites......257

TABLE 9: Northern Italy: Imperial period sites......258

TABLE 10: Northern Italy: Late Antiquity sites......259

TABLE 11: Details on screening, preservation conditions, and carnivore gnawing amongst Roman period sites in Italy......260

TABLE 12: Number of teeth, NISP, and #teeth/NISP figures for Roman period sites in Italy......262

TABLE 13: Total sample, NISP sample, and NISP values for animal taxa from Roman period sites in Italy......263

TABLE 14: Frequency of mammalian taxa represented from faunal deposits amongst four categories of Roman period sites in Italy......266

TABLE 15: Mean NS/NISP ratios according to geographic region, temporal period, and site type groupings......267

TABLE 16: NISP frequencies for mammalian taxa among sites in Roman Italy......268

TABLE 17: MNI frequencies for mammalian taxa at Roman period sites in Italy......270

TABLE 18: Mean NISP frequency of mammalian taxa according to site type......272

TABLE 19: Mean MNI frequency of mammalian taxa according to site type......273

TABLE 20: Cattle: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type......274

TABLE 21: Cattle: Fusion data......275

TABLE 22: Cattle: Dental data......276

TABLE 23: NISP frequency of cattle according to sex (part 1)......277

TABLE 24: NISP frequency of cattle according to sex (part 2)......278

TABLE 25: Cattle: Age and sex correlation......279

TABLE 26: Cattle: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups......280

TABLE 27: Cattle: Incidence of non-dental abnormalities from Roman period sites in Italy......281

TABLE 28: Cattle: Incidence of dental abnormalities from Roman period sites in Italy....282
TABLE 29: Sheep/goat: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type....283
TABLE 30: NISP frequency of sheep (s) and goat (g) bones from Roman period sites in Italy....284
TABLE 31: Range and mean frequency of sheep and goats according to site type....285
TABLE 32: Range and mean frequency of sheep and goats according to geographic area....286
TABLE 33: Range and mean frequency of sheep and goats according to temporal period....287
TABLE 34: Sheep/goat: Fusion data....288
TABLE 35: Sheep/goat: Dental data....289
TABLE 36: NISP frequency of sheep/goats according to sex....290
TABLE 37: Sheep/goat: Age and sex correlation....291
TABLE 38: Sheep/goat: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups....292
TABLE 39: Sheep/goat: Incidence of non-dental abnormalities from Roman period sites in Italy....293
TABLE 40: Sheep/goat: Incidence of dental abnormalities from Roman period sites in Italy....294
TABLE 41: Pig: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type....295
TABLE 42: Pig: Fusion data....296
TABLE 43: Pig: Dental data....297
TABLE 44: NISP frequency of pigs according to sex....298
TABLE 45: Pig: Age and sex correlation....299
TABLE 46: Pig: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups....300
TABLE 47: Pig: Incidence of non-dental abnormalities from Roman period sites in Italy....301
TABLE 48: Pig: Incidence of dental abnormalities from Roman period sites in Italy....302
TABLE 49: Cattle: Butchery data....303
TABLE 50: Sheep/goat: Butchery data....304
TABLE 51: Pig: Butchery data....305
TABLE 52: Mean meat weights (kg) for individual cattle, sheep/goat, and pigs from Roman Italy according to region and time period groups....306
TABLE 53: Domestic and wild mammal mean meat weight frequencies according to geographic region, time period, and site type groups....307
TABLE 54: Mean meat weight frequencies for cattle, sheep/goat, and pigs at "special" sites; calculated on the basis of NISP values....308

TABLE 55: Mean meat weight frequencies for cattle, sheep/goat, and pigs per site type; calculated on the basis of NISP values....309

TABLE 56: Mean meat weight frequencies for cattle, sheep/goat, and pigs at "special" sites; calculated on the basis of MNI values....310

TABLE 57: Mean meat weight frequencies for cattle, sheep/goat and pigs per site type; calculated on the basis of MNI values....311

TABLE 58: Range and mean frequency of cattle parts according to site type; calculated using NISP frequencies for those bones which comprise each category....312

TABLE 59: Cattle parts mean frequencies as standardized statistic for site type....313

TABLE 60: Cattle parts mean frequencies as standardized statistic for geographic area and site type....314

TABLE 61: Cattle parts mean frequencies as standardized statistic for temporal period....315

TABLE 62: Range and mean frequency of sheep/goat parts according to site type; calculated using NISP frequencies for those bones which comprise each category....316

TABLE 63: Sheep/goat parts mean frequencies as standardized statistic for site type...317

TABLE 64: Sheep/goat parts mean frequencies as standardized statistic for geographic area and site type....318

TABLE 65: Sheep/goat parts mean frequencies as standardized statistic for temporal period....319

TABLE 66: Range and mean frequency of pig parts according to site type; calculated using NISP frequencies for those bones which comprise each category....320

TABLE 67: Pig parts mean frequencies as standardized statistic for site type....321

TABLE 68: Pig parts mean frequencies as standardized statistic for geographic area and site type....322

TABLE 69: Pig parts mean frequencies as standardized statistic for temporal period....323

LIST OF FIGURES

FIGURE 1: Location of Sites....324

FIGURE 2: #teeth/NISPx100 figures for Roman period sites in Italy....326

FIGURE 3: Frequency of Roman period sites in Italy with recovered animal bones according to NISP sample sizes....327

FIGURE 4: Number of sites per NISP sample size category and site type....328

FIGURE 5: Number of sites per NISP sample size category and region....329

FIGURE 6: Number of sites per NISP sample size category and time period....330

FIGURE 7: Mean NISP frequencies for cattle, sheep/goat, and pig among Roman period sites in Italy....331

FIGURE 8: Mean NISP frequencies for equids, dogs, cats, wild animals, and rodents among Roman period sites in Italy....332

FIGURE 9: Mean MNI frequencies for cattle, sheep/goat, and pig according to geographic region/time period/site type categories....333

FIGURE 10: Mean MNI frequencies for equids, dogs, cats, wild animals, and rodents according to geographic region/time period/site type categories.... 334

FIGURE 11: Cattle: NISP and MNI mean frequencies by site type....335

FIGURE 12: Cattle: NISP and MNI frequencies by geographic area, time period, and site type....336

FIGURE 13: Cattle metacarpal Bd measures from Period 1....337

FIGURE 14: Cattle metacarpal Bd measures from Period 2....337

FIGURE 15: Cattle metacarpal Bd measures from Period 3....337

FIGURE 16: Cattle metatarsal Bd measures from Period 1....338

FIGURE 17: Cattle metatarsal Bd measures from Period 2....338

FIGURE 18: Cattle metatarsal Bd measures from Period 3....338

FIGURE 19: Sheep/goat: NISP and MNI mean frequencies by site type....339

FIGURE 20: Sheep/goat: NISP and MNI frequencies by geographic area, time period, and site type....340

FIGURE 21: Pig: NISP and MNI mean frequencies by site type....341

FIGURE 22: Pig: NISP and MNI frequencies by geographic area, time period, and site type....342

FIGURE 23: Mean meat weight frequencies of cattle, sheep/goat, and pig according to geographic region/temporal period/site type groups; calculated on the basis of NISP values....343

FIGURE 24: Mean meat weight frequencies of cattle, sheep/goat and pig according to geographic region/temporal period/site type groups; calculated on the basis of MNI values....344

LIST OF ABBREVIATIONS

• Ancient Texts and Related Documents

Acc.	Accius
Ael. *NA*	Aelian (or Aelianus), *De natura animalium*
Alf. *Dig.*	P. Alfenus Varus, *Digesta*
Amm. Marc.	Ammianus Marcellinus
Apic.	Apicius, *De re coquinaria*
Arn. *Adv. nat.*	Arnobius, *Adversus nationes*
ARS	Johnson, A.C., P.R. Coleman-Norton, and F. Bourne (eds.), *Ancient Roman Statutes* (1961)
Aul. Gell.	Aulus Gellius, *Noctes Atticae*
BGU	*Berliner Griechische Urkunden. (Äegyptische Urkunden aus den Kgl. Museen zu Berlin)*
Caecil. *com.*	Caecilius Statius, comedies (The Changeling)
Caes. *B Civ.*	Caesar, *Bellum Civile*
Caes. *B Gal.*	Caesar, *Bellum Gallicum*
Calp. *Ecl.*	Calpurnius Siculus, *Eclogues*
Cassiod. *Var.*	Cassiodorus, *Variae epistulae*
Cato *Agr.*	Cato, *De agri cultura*
Cels.	Celsus, *Artes* or *De medicina*
Cic. *Fam.*	Cicero, *Epistulae ad familiares*
Cic. *Fin.*	Cicero, *De finibus*
Cic. *In Pis.*	Cicero, *In Pisonem*
Cic. *Off.*	Cicero, *De officiis*
Cic. *Quinct.*	Cicero, *Pro Quinctio*
Cic. *Scaur.*	Cicero, *Pro Scauro*
CIL	*Corpus Inscriptionum Latinarum*
CJ	*Corpus Juris Civilis* (i.e., The Civil Law)
CLA	D.R. Shackleton Bailey (ed.), *Cicero's Letters to Atticus*, 7 vols. (1965-1970)
Col.	Columella, *De re rustica*
Const. Leo	New Constitutions of the Emperor Leo
CTh	*Codex Theodosianus*
Dig.	*Digesta*
Dion. Hal.	Dionysius Halicarnasseus
Ed. Diocl.	*Edictum Diocletiani* (i.e., Edict of Diocletian)
ERC	*Epigrafi Romane di Canosa*
FIRA	*Fontes Iuris Romani Antejustiniani*
Frontin. *Str.*	Frontinus, *Stratagemata*
Fronto *Ep.*	Fronto, *Epistulae*
Grat. *Cyn.*	Grattius, *Cynegetica*
Hor. *Carm.*	Horace, *Carmina*
Hor. *Epist.*	Horace, *Epistulae*
Hor. *Epod.*	Horace, *Epodes*
Hor. *Odes*	Horace, *Odes*
Hor. *Sat.*	Horace, *Saturae*
ILS	*Inscriptiones Latinae Selectae*
Inscr. Ital.	*Inscriptiones Italiae* (1931/2-)
Isid. *Etym.*	Isidorus, *Etymologiae*
Isid. *Orig.*	Isidorus, *Origines*

Varro *Sat. Men.*	Varro, *Saturae Menippeae*
Varro *Rust.*	Varro, *De re rustica*
Veg. *Mil.*	Vegetius Renatus, *De re militari*
Verg. *Ecl.*	Virgil, *Eclogues*
Verg. *G.*	Virgil, *Georgics*

- **Zooarchaeological Data**

The following abbreviations are commonly used in the text in relation to the zooarchaeological data. Most occur in the tables and figures.

R		**geographic region**
	S	southern Italy
	C	central Italy
	N	northern Italy
P		**temporal period**
	1	Period 1 (c. 500 BC - c. 50 BC); roughly, the **Republican** period
	2	Period 2 (c. 50 BC - c. AD 300); roughly, the **Imperial** period
	3	Period 3 (c. AD 300 - c. AD 500); roughly, **Late Antiquity**
T		**site type**
	r	rural
	u1	urban1, or city
	u2	urban2, or settlement
	sp	special

na data not available

Unless otherwise stated, sites are arranged in the tables according to geographic area, temporal period and site type. Thus all sites in southern Italy are presented first, with these organized according to temporal period, beginning with Period 1. The sites within each geographic region/temporal period cluster are further arranged by type (i.e., r, sp, u1 and u2).

- **Skeletal Elements**

The following are abbreviations used for the various skeletal elements:

carp/tars	carpal/tarsal
fem	femur
fib	fibula
hum	humerus
MC or mc	metacarpal
MP or mp	metapodial
MT or mt	metatarsal
pelv	pelvis
phal	phalanx
PM	premolar
rad	radius
scap	scapula
tib	tibia
vert	vertebrae

Introduction

Animals are the mirror of nature. (Cic. *Fin.* 2.32)

Practically every cultural group, past and present, relies on animals. Animals supply meat, milk, and other edibles for our diet; and they furnish skins, wool, hair, sinew, bones, traction, transportation, companionship, and other resources or services for our economic, social, and technological well-being. The animals of the ancient Romans in Italy were no exception. We are able to determine details about their role in Roman Italian life through two prominent means. First, a number of ancient texts survive which document aspects of this topic. Latin authors describe various types of animals, and provide details about their care, maintenance, and role in Roman life, not to mention the dietary resources they supplied. A second source is zooarchaeological data. A piece of excavated bone may reveal information as to the species of animal it came from and that animal's age, sex, and state of health; it may also provide evidence for cultural practices such as butchery and cooking. Thus, animal bone analyses can reveal much about the animals themselves as well as the cultures which kept, controlled, killed, ate, and exploited them.[1]

While textual and archaeological data may provide a great deal of information about the role of animals in Roman Italian life, many issues remain unresolved, including several key components of the Roman economy. Amongst these elements, scholars assert that the issue of production and consumption, especially as it relates to urban-rural linkages, requires full attention. However, no one has yet attempted to use the excavated animal remains as a source of primary information for an extended study of this topic.[2] Furthermore, aside from a few incidental connections, no one yet has linked, in any detail, this source of data with animal references in the ancient Roman texts. Combined investigation is required to expand our knowledge.

In this thesis I analyze and connect these two sources of data—(i) animal bone remains from Roman period urban and rural archaeological sites in Italy, and (ii) references to animals in ancient Roman texts—in order to identify commonalities and deficiencies in terms of the topics they cover and the information they provide about production and consumption of animal resources in Roman Italy. Their combined analysis is used to construct a more comprehensive picture of the role of animals in the diet and economy of Roman Italy.

---

[1] Images of animals as portrayed in Roman art (i.e., painting, mosaics, sculpture, etc.) are a third source of information; however, their analysis is complicated, especially by variations in artistic styles, and, in the interests of time, I shall not consider them in this thesis. Toynbee (1973) discusses animals in Roman life by incorporating a number of artistic depictions with a general review of the textual data.

[2] At least in Roman Italy, and to similar extent throughout the Roman Mediterranean. The contribution of zooarchaeology to our understanding of the ancient economy and diet in the Roman northwest provinces, especially Britain, continues to receive much attention (e.g., Grant 1989; King 1978, 1984; Lauwerier 1988; Luff 1982; Maltby 1984, 1994; Thomas 1989).

Zooarchaeology and ancient texts each supply information to our understanding of animal production and consumption in Roman Italy, but not necessarily in equal amounts or in a complementary fashion. Sometimes there is much information about a particular subtopic; at other times very little can be inferred or reconstructed. Sometimes the material presented by each source of data overlaps and in other cases it might conflict. Thus, only by using both sources of information, ancient references and zooarchaeological remains, can we get a better idea of the strengths and shortcomings of each when it comes to our understanding of animals in the economy and diet of Roman Italy, as well as identify the potential of collaborative efforts.

While a full comparison and integration of textual and zooarchaeological data concerning animal production and consumption in Roman Italy is an important step in our reconstruction of this aspect of the ancient economy, I believe that this picture is incomplete without some manner of testing these data in a theoretical framework, or model, about animal production and consumption in general. I have chosen to test the zooarchaeological data, in light of the textual references to animals in the ancient texts, with the criteria listed in Gillian Clark's (1987) economic complexity model. Her model, which is explained in greater detail in Chapter 3 of this thesis, outlines expected patterns in the zooarchaeological data which are characteristic of various scales of animal production and consumption, from self-sufficient nuclear families at one end (which produce and consume their own animals and animal goods) to market and inter-regional exchange mechanisms at the other end (where production of surpluses occurs, and different centres for production, distribution and consumption exist). Clark's model will allow me to recognize levels of intra- and inter-site movement of animals and animal products for Roman Italy, and thereby supplies an important component to our understanding of the ancient economy.

Italy was chosen as the region of study for several reasons. First, it was the core of the Roman empire and the geographic foundation for Roman culture. Analysis of the role of animals in the diet and economy in Italy is a vital prerequisite for better understanding their contribution in other parts of the Roman world. Italy was a rich and powerful centre which exerted considerable influence over its territories. It was a well populated region by the standards of the Empire; most of its inhabitants were also economic assets to the Empire as they were producers of either food, goods, or services (Weitz 1972: 22). Italy's agricultural and animal wealth was even noted by the ancient author Pliny the Elder (*NH* 37.8.77) who described it as "the country which is the most beautiful and which deservedly holds first place in all the products of nature," adding that "she is unsurpassed by no land in any of those products which human life ought to feel in want of: cereals, wine, olive oil, wool, flax, clothing, and cattle." The fact that Pliny specifically mentions cattle amongst these products reinforces the prominence of Italy as a land of animal resources.

A second reason for choosing Italy was that it—but especially the city of Rome—was the centre of Latin literature. Many ancient authors were born and/or educated in Italy, or at least familiar with the country, and a number of them wrote about the Roman Italian way of life.

Finally, Italy has been a place of extensive archaeological activity for at least two centuries now. It contains a variety of sites ranging from sanctuaries to rural villas to urban settlements and cities. Animal bones have been recovered at many of these.

While there are some notable exceptions, previous studies of animal bone remains from Roman sites in Italy have been few and generally quite limited in scope. Classical archaeologists and ancient historians have traditionally paid little regard to the study of animal bones from Roman Italy. Consequently, faunal remains were not always retrieved during excavation, and when they were saved, the bones often received just a brief analysis. Many earlier reports consisted only of a species identification and a short morphological description. Several of these studies attempted to quantify the remains and provide some details about the role these animals may have fulfilled in the ancient economy, but in most cases this analysis assumed a subordinate relevance to the investigation of the architectural and material (primarily ceramic) remains recovered from the site. Recently, however, the discipline has been changing, as classical archaeologists, aware of the theoretical directions being defined in processual and post-processual archaeology, have begun to reshape their methods and goals (Dyson 1993). Animal bones are now recovered at most sites. Moreover, attempts are now being made to establish a connection between faunal remains and the economic organization of Roman society at the local, regional, and provincial levels, and to examine the nature of exchange, redistribution and trade as it relates to animal husbandry and dietary changes.

Although the potential of animal bone studies in Classical Archaeology is increasingly realized, we still need fundamental integrative research in this field. Only rarely have the zooarchaeological results from specific archaeological sites been compared, let alone correlated, with others. Most have been considered in isolation. This isolation also often separates the interpretation of the animal bone remains from the many references to animals in the ancient texts.[3] In this thesis, I attempt to broaden our understanding of the animal economy of Roman Italy through extensive analyses of textual and zooarchaeological data. The integrative study of both of these sources of data should assist in establishing links between and amongst these archaeological sites, which at present are interpreted mainly at a limited site-specific level. By testing the data using Clark's (1987) economic complexity model I will bind these sites into a spatial and temporal economic network based on the faunal materials recovered from each, and in light of the information gleaned from the ancient texts. In order to accomplish this, I focus on two key concepts: production and consumption. Production deals with aspects of animal husbandry, while consumption here encompasses the subsequent trade, transport, sale, and distribution of animals and their products, as well as the contribution, preparation, and disposal of meat and other animal resources in the Roman diet.

Discussion of production and consumption of any commodity in Roman Italy hinges on the greater issue of the ancient economy, about which an introductory note must be made

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[3] This separation is exacerbated by the traditional divides of academic disciplines. Animal bone studies are commonly sponsored by Anthropology and Archaeology departments, while the analysis of ancient Greek and Latin texts is generally under the auspices of a Classics or Classical Studies department. Interdisciplinary research is vital in order to link faunal and textual data.

before I can deal with the zooarchaeological and textual data for the role of animals in the Roman economy in particular. Considerable debate exists on this topic. The principal controversy pits those who view the ancient Roman economy as essentially "minimalist" (Whittaker 1997: 422) in nature against those who believe it to contain characteristics of more advanced, modern economies. It is not my intention here to detail the specifics of this debate (which can be found in Duncan-Jones 1974; Engels 1990; Finley 1973, 1985; Frederiksen 1975; Garnsey et al. 1983; Jones 1974; Jongman 1988; Morely 1996; Nippel 1987-9; Whittaker 1995, 1997; among others), but rather to formulate a working model of those aspects of the ancient economy that are relevant to this thesis.

It is generally agreed that agriculture was the dominant form of economic activity during Roman times (Jones 1974: 83), and as such it permeated many aspects of everyone's life. All Romans consumed agricultural produce, while the majority of them had some connection with the land, be it as actual farmers, wealthy landowners, or as suppliers or dealers of agricultural goods. Land owning was considered a socially respectable form of investment, and agriculture a fairly safe economic pursuit (Aubert 1994: 117). Agricultural production centered in the countryside; towns consumed some of these resources. While food was probably the major commodity traded or redistributed during Roman times, with few exceptions, such as in providing for some of the major cities (e.g., Rome, Corinth[4]) or the army, food supplies generally traveled short distances since most areas could survive off of local resources. Many farmers produced goods for themselves while markets provided an outlet for the sale of animal products to those who could not supply themselves with these resources. Markets, however, were not the open capitalist enterprise common to us today, but, rather, were restricted in their operation and purpose. There was no mass-market during Roman times. Transport and technological deficiencies inhibited economic growth, while long-distance trade was generally limited to either food provisions such as grain, oil, wine, and fish sauce (e.g., *garum*) for megacities like Rome, or on a much smaller scale, movement of foreign luxury goods. Although industry developed, it always remained modest in operation, and was rarely seen as a means to acquire a great fortune. Instead, investment in the land was believed to bring status and wealth during antiquity (Aubert 1994: 117). A major source of income for many urban consumers, therefore, came from rural rents and taxes and not from commercial enterprises (Jones 1974: 83). Status could be demonstrated by extravagant displays of consumption and expenditure on public benefaction and entertainment, and much wealth was spent for these purposes rather than cautious saving or shrewd investment.

The pre-eminence of agriculture during antiquity presupposes the importance of animal resources in the ancient economy. Animals are integral to rural agricultural life as both working beasts and sources of meat. As such, they figure in the realms of both production and consumption. Farmers and herders produce animals in order that the meat, milk, hides, and other materials from these animals can be consumed. Furthermore, since production and consumption impinge on many aspects of a culture, one cannot ignore issues of trade, transport, marketing, and distribution of these goods in any economic study. Thus, topics such as the movement of animal goods, the acquisition and purchase of animals by various groups of people, and the organization of meat markets must all be considered for a complete analysis of production and consumption in the ancient world. Finally, compensation needs to be made for those factors, such as changes in political, social, religious, military, and technological realms, which might directly or indirectly affect the animal economy. For example, increased agricultural production facilitated by military takeover of an area can stimulate the economy, while a socially inspired or religious distaste for beef might cripple the production and consumption of cattle.

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[4] There are a number of large cities in antiquity which could not be supplied from their hinterland. Rome is perhaps the most common example, but Engels (1990) has demonstrated a similar situation for ancient Corinth as well.

Considering the many aspects of production and consumption of animals and animal goods in antiquity, coupled with the need to analyze the requisite data within the complete cultural context of that period, it is apparent that a full examination of the role of animals in the diet and economy of Roman Italy is a momentous task. Although, as mentioned above, I recognize that topics such as trade and transport, marketing, sale, and distribution are components of production, they shall not be detailed here since their analysis lies outside of the scope of this thesis. There is little zooarchaeological evidence available to aid in the analysis of these specific topics, and thus insufficient faunal data to compare with the textual references pertaining to the trade, transport, marketing, sale, and distribution of animals and animal goods in Roman Italy.

There are four main parts to this thesis. The first section sets the background for the ensuing analysis of production and consumption. I introduce and organize the two sources of data, textual and zooarchaeological, setting each within context. I outline the potential and problems of these sources in the reconstruction of the role of animals in Roman Italy, before presenting a list of zooarchaeological expectations derived from modeled assemblages of bone waste deemed characteristic of productive and consumptive activities. These criteria, which are based on Clark's (1987) economic complexity model, form the basis for testing the zooarchaeological data from Roman period sites in Italy in subsequent chapters.

The second section of this thesis is devoted to the topic of production. I present the zooarchaeological and textual data for animal husbandry for the principal mammalian taxa—cattle, sheep/goat, and pig—then combine the two data sources for an integrated picture. The results from each taxonomic group are then tested against the modeled criteria to determine patterns of animal production during antiquity. I discuss the outcome of these investigations for the three main animal taxa, paying close attention to, and offering explanations for, signs of temporal and spatial continuity and/or change in terms of animal resources.

The third section of the thesis is concerned with consumption. I outline, discuss, and integrate the zooarchaeological and textual data for consumption under the broad headings: butchery & meat preservation, and diet. Following individual discussion of these subtopics of consumption, the results are tested against the modeled criteria and explanations are provided for the patterns shown.

In the final section I draw conclusions about the combined capacity of these two sources of data—zooarchaeological remains and ancient textual references—to augment our knowledge of animal production and consumption in Roman Italy. Moreover, I outline the value of developing economic frameworks in our understanding of the role of animals during Roman times.

As a zooarchaeologist I do focus on the animal bone evidence. Part of this is because less has been written about it than about Latin texts (scholars have been analyzing ancient texts for hundred of years). However, I do not consider zooarchaeological data superior to, or more accurate than, the textual record. Considerable debate exists on the relative value of archaeological and historical data (Feinmann 1997), with scholars trying to establish which is "better," often by citing apparent contradictions between the two. I believe that neither source offers any superior picture and concur with Feinmann (1997: 372) that:

> independent consideration followed by careful juxtaposition of these records provides a stronger basis for interpretation than an analytical slant that blanketly prejudices the importance of one set of data...while diminishing another...

Thus, only by integrative research, analyzing and linking both archaeological and textual data, can we hope to reduce the biases and shortcomings inherent in a reliance on each individually and be better able to develop a more complete picture of the role of animals in the diet and economy of Roman Italy.

Chapter 1

THE ANCIENT TEXTS

> Your query, said Servius, is a good example of what comes from our neglect of reading the old texts; for, since our generation has deserted Ennius and all our old literature, we are ignorant of much that would be clear to us were it our usual practice to read the works of our old authors. (Macrob. *Sat.* 6.9.9, c. AD 384)

Introduction

A large number of written texts are available from Roman times, which contain a wealth of information about politics, history, geography, and life in general. Scholars have devoted much attention to translating these texts, and to interpreting the events and characters chronicled and described within. However, also included in many of these texts is a variety of references concerning the role of animals in Roman life. Several authors have considered aspects of production and consumption of animals during Roman times on the basis of these recording. White (1970a, 1974) and Martin (1971) discuss principles of Roman farming as documented in the ancient agricultural treatises of Cato, Varro, Columella, Virgil, and Palladius, and supplement this with further references, especially information gleaned from recordings in Pliny the Elder's volumes. Other authors have also conducted research on the ancient agricultural writers.[5] Although important in advancing our understanding of the practicalities and economics of Roman agriculture, and especially grain and vine cultivation, these secondary sources are not exclusively or principally concerned with animal husbandry. Moreover, they do not deal expressly with the consumption of animals and animal products, while their focus on the agricultural writers neglects the references to animals found in other Roman texts. Toynbee (1973) provides an excellent general survey of textual and artistic evidence for a range of domestic, wild, and exotic animals, but her volume is not intended to provide specific details of production and consumption of animals throughout the Roman world. Other scholars have used the ancient texts in their analyses of various animal-related topics such as sheep-raising (Frayn 1984; Ryder 1983), pork production (Barnish 1987; Sirks 1991), poultry farming (Ghigi 1939), or the meat diet (Corbier 1989; Lauwerier 1986) but in each case the scope has been restricted. As yet the collection of references concerning the many aspects associated with animal production and consumption from a broad range of ancient texts (and not just the agricultural writers) have not been brought together fully nor studied in any great detail for the data they yield about the role of animals in both the diet and economy of Roman Italy.

While the secondary sources noted above provide invaluable information, where possible I chose to return to the primary sources themselves (i.e., the ancient texts) to build my database of animal references. I reviewed these ancient texts in an effort to extract the most significant references to animals in Roman Italy. Recovering animal references from the immense number of Roman texts available is a considerable task so I will limit the resources to those works originally written in Latin (with a few exceptions such as Aelian's *De natura animalium*, and Strabo's *Geography*, written in Greek) which have the greatest potential to contain such references. Of all the ancient languages, Latin continued to be the dominant language of Italy for most of the millennium from the 5th century BC until the 5th century AD (Adkins and Adkins 1994: 203). Numerous texts in other languages such as ancient Greek (note exception made for some Greek works above), Celtic, Punic, etc. may contain animal references, perhaps with indirect attention to Roman Italy. Presumably, however, anything that they record either has no direct bearing on Roman Italian life, or has been documented within one of the Latin texts and thus they have not been consulted for this thesis. Translations have been used throughout, most of which derive from the Loeb Classical Library series.

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[5] White (1970b) provides a bibliography of scholarship on Roman farming.

Since there are many types of Latin literary sources, including histories, biographies, speeches, poems, plays, practical manuals, philosophical works,[6] law books, and personal letters, it is necessary to select those sources which have the greatest possibility of containing animal references. Thus, for this thesis I used practical manuals and treatises dealing with aspects of agricultural life; encyclopedic volumes about science or nature; all types of poetry (especially elegies, epigrams, pastoral verse, didactic poetry, and narrative poetry) which refer to aspects of country or city life; letters and prose dialogues detailing events on the farm; cookbooks with recipes requiring animal products; and satirical, comedic, or incidental comments about a variety of everyday topics like eating and animal sacrifice, as the main sources of reference.

A list of the principal authors and ancient works consulted for this thesis, in rough chronological order according to date of writing, is given in Table 1. Appendix 1 groups these texts according to literary type or genre (e.g., agricultural manual, epigram, pastoral poetry, etc.) and includes notes about: (i) the potential of each of these types to contain animal references, (ii) the primary context for these recordings, and (iii) their reliability in terms of animal references.

While overall Roman speeches, epics, dramatical tragedies, histories, and biographies were judged to have fewer references than other types of Roman texts, there were occasions when relevant sections of them were consulted. These are listed in Table 2, along with other textual works with relatively few references to animals.

A major problem for those works with only incidental reference to animals is that it is

> difficult to understand these casual indications for the reason that they assume as common knowledge just those obscurities which we are trying to probe. (Pinner 1958: 9)

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[6] The ancient Greek, Roman, and Christian philosophers (Aristotle, Plato, Theophrastus, Porphyry, Plutarch, Augustine, Boethius, Jerome, among others) deliberate the morality and ethics behind meat-eating, animal sacrifice, animal emotions, animal exploitation, and other philosophical topics which are outside the scope of this thesis. Sorabji (1993) provides excellent discussion and further references.

Nevertheless, combined, and used in conjunction with relatively comprehensive works about animals, such as the agricultural treatises, all of these incidental pieces of information have a much better chance of filling in the gaps posed by any individual analysis.

In addition to these literary texts, important inscriptional evidence relating to animals was examined in this thesis. Most of these inscriptions and documents can be found in the *Corpus Inscriptionum Latinarum (CIL)* volumes.

Biases and Limitations

Before information about the role of animals in Roman life can be extrapolated, the biases and limitations of these written sources must be outlined. Several problems hinder the use of Roman texts as a source for cultural reconstruction: (i) the identity of the audience, (ii) temporal and spatial biases, and (iii) reliability.

(i) The Audience

One major uncertainty of using Roman texts as a source for accurate representations of animals is determining the audience, for it is the readers who often dictate the style and content of a textual work. Literacy was a rare phenomenon in the Roman world. A rough estimate of the extent of literacy in Roman Italy diverges from c. 20-30% for males to less than 10% for females (Harris 1989: 266). Levels were likely much lower during the early Republic, and probably somewhat elevated in late antiquity (Harris 1989), but it is doubtful that more than a quarter of the population in Italy at any given time was literate. Generally, only the rich could afford the necessary education to read and write (Harris 1989; Lewis and Reinhold 1990: 198) so it is no surprise that wealthier regions of Italy such as Campania, Umbria, and Venetia, as well as important urban areas such as Rome and the Bay of Naples contain a greater density of monumental inscriptions (i.e., a marker of literacy) than other parts such as Liguria or Lucania (Harris 1989: 265-266). Roman authors, themselves upper-class and educated citizens, basically catered to a similar audience. There are exceptions (e.g., some examples of graffiti, town postings, epitaphs of poor people), but, on the whole, a clear affluent bias is prevalent amongst the majority of Roman texts. Such a bias virtually ignores the labours of the poorer classes, including the small subsistence farmers who are thought to have played important roles in local economic interactions, including husbandry practices, and who had great influence upon rural diets as well (Frayn 1979; Steiner 1955).

Estimating the number and dietary impact of poor and middle-class farmers in antiquity is contingent on estimates of the average farm plot. However, we have very little information about what should have been the average size of agricultural estates at any given period or in any given area of the Roman world. The agricultural writers provide some clues. Cato (*Agr.* 10-13) discusses, for the sake of example, a vineyard of 100 *iugera* (1 iugerum = c. 0.252 hectares) and an olive grove of 240 *iugera*. Varro (*Rust.* 1.18-19) repeats these figures, noting nothing unreasonable or exceptional about them, while Columella (2.12.7) mentions an estate of 200 *iugera* of arable land. These examples might indicate the average size of plots for fairly well-off individuals.[7] However, the majority of farmers were poor

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[7] See Duncan-Jones (1974: 325-326) for more on estate-sizes.

(Frayn 1979; Hopkins 1980). Statistics from the Ligures Baebiani, a bronze inscription containing a list of property loans and dating to AD 101, as well as the Table of Veleia, another fragmentary bronze inscription containing information about property values and dating to AD 102/13, indicate a great range in estate sizes. The average value of the 15 largest properties is HS 164,600 (HS = *sesterces*) in the Ligures Baebiani, and HS 230,813 in the Table of Veleia, while the average size of the 15 smallest properties is HS 25,066 and HS 15,037, respectively (Duncan-Jones 1974: 210-215 and App.4, 336). The smallest estate recorded in the Ligures Baebiani is HS 14,000. Relating property values (in HS) to plot sizes (in *iugera*) is a difficult task. Columella (3.3.8) claims 1,000 HS buys one *iugerum*, but this price is much exaggerated (Duncan-Jones 1974: 51). Alternatively, Egyptian averages of 150-200 HS per *iugerum* (for 1st and 2nd centuries AD) are quite low (Duncan-Jones 1974: 51 and App. 16, 366). Taking HS 400-500 as the average between these two extremes and applying this number to the property values from the Ligures Baebiani yields figures of c. 50, and c. 300 *iugera* for the average small, and large farm, respectively (Small and Buck 1994: 31). Attempts to define a minimum plot size, based on the calculation of basic needs of a small household, are wrought with difficulties considering that many small landholders relied on other resources like fishing, hunting, fruit-picking, or temporary work to support their family (Aubert 1994: 127).

If the labours of the small-scale rural farmer are not ignored then often they are glorified, as in the pastoral poetry of Virgil, Calpurnius, and Nemesianus, or the satires of Horace, Juvenal, and Persius. The Roman people were well aware that their Empire had been built upon a solid foundation of agriculture and pastoralism, and knew the importance the land played in maintaining their domain. Rural life, therefore, was often venerated as an idyllic world—a peaceful setting used in a manner to provide a literary experience for an audience of primarily rich city dwellers. There is doubt, however, as to how far and in what particular aspects this glorified picture of country life was removed from its realistic counterpart. Such a lifestyle surely presented for its occupants a variety of perils and hardships which either escaped reference in the texts or were embellished in some manner.

The Roman agricultural treatises are an important source of animal information, but they contain a mixture of descriptive and prescriptive details, which renders it difficult to judge how widespread and in what capacity their advice was followed. The fact that these agronomists use examples and anecdotes to illustrate concepts, however, shows that they were aware of possible problems the farmer might encounter. They regularly offer practical advice to counteract these perils, which in turn shows a vested personal interest in agricultural work, as opposed to writing their work as some theoretical or rhetorical exercise. While these manuals are not perfect reflections of Roman farm life, they do help illustrate the potential of Roman agriculture (Morley 1996: 108).

Although these agricultural manuals often contain practical information which can be adapted for all levels of farming, they are clearly oriented towards an upper-class audience operating at a rural villa (Steiner 1955; White 1970a). Generally, they promulgate the idea of profit maximization for the wealthy, inexperienced, and frequently absentee landowner, even if some, such as Cato's and Virgil's treatises, directly concern *vilici*, or the actual bailiffs who manage the estates (Aubert 1994: 132; Purcell 1985: 5-8). Olives and vine crops brought relatively more earnings than most other agricultural pursuits. Thus, methods for their cultivation are chronicled in considerable detail by the agricultural writers. Most forms of animal husbandry and stock-raising are given secondary treatment by the agronomists, with one exception. Varro devotes much attention to large-scale ranching ventures, in part surely because he was involved in this activity, but more likely because it was the only form of husbandry that yielded abundant wealth and prestige.

Where animals are mentioned amongst these ancient texts, explicit details and statistics about herd sizes, species morphometrics, butchery practices, regional diversity, and various other aspects of economic exploitation are usually lacking. The agricultural writers preferred to expand upon descriptive aspects, such as visually distinguishing breeds, as well as practical procedures of herd care and maintenance. They give little quantitative data; other writers provide even less.

(ii) Temporal and Regional Biases

Another problem of using the ancient texts as a source of animal information is that there are temporal and regional biases to be taken into account. As Table 1 shows, there are significant gaps in the chronological continuum, especially prior to the 2nd century BC and during the 2nd and 3rd centuries AD, for which only a few literary texts and absolutely no agricultural manuals are available. The bulk of the extant sources derives from the 1st century BC to the 1st century AD, during the Golden and Silver Ages of Latin literature—the era when many of the "great" Roman authors lived. Their works have, on the whole, survived best because they were the most read and reproduced of all Latin texts. Consequently, our record of the role of animals in Roman life and culture is biased in favour of certain periods, and is primarily based on recordings of the "great" authors. The problem is not highly significant for the 2nd and 3rd centuries AD, since Palladius' 5th century AD farming treatise provides some link in animal husbandry practices between the Silver/Golden Ages of literature and Late Antiquity. However, the lack of agricultural records, and, for that matter, any extant written text with good animal references prior to the 1st century BC, seriously limits our literary understanding of the role of animals during these formative years of the Roman world.

Late Antiquity presents another problem in the analysis of animals in Roman Italy. Although there are a number of Late Antique Latin texts which have survived, most of these principally deal with Christian philosophy and/or ecclesiastics (e.g., the writings of Cyprian, Ambrose, Augustine, Jerome, Lactantius, Paulinus, Benedict, and Boethius). I have reviewed these sources and found them to contain very little information pertinent to the animal economy of Italy when compared with the many Republican and Imperial period literary works on fundamentally non-religious topics like agriculture. Consequently, I have not extensively consulted these Late Antique Christian texts for this thesis.

A temporal dilemma might also exist when we consider that authors from later periods frequently borrowed material and ideas from earlier works. We cannot be totally sure that the material adopted still accurately reflected the current practice, but it seems plausible. Borrowed information, therefore, presumably represents continuity over time, whereas the recording of any new or novel concept likely indicates some type of change. Whether or not this change was accepted might be gauged by the frequency of its repetition elsewhere in both contemporary and later texts.

In terms of spatial matters, the ancient texts also contain biases. On the one hand, those works with a heavy agricultural component frequently deal with large-scale, productive farms, most of which are located in the agriculturally rich lowland and coastal areas centered in the Po River Valley in northern Italy, the plains surrounding Rome, and in Campania. Animal resources from marginal and remote areas are commonly ignored. Does this mean that animals were not herded or raised outside these popular regions or that such areas were simply not worth documenting for some reason? The latter is likely. On the other hand, some references, especially those contained in pastoral poetry, are rather generic in setting, and cannot be pinpointed to a specific location. Are we to assume that these represent universal practices? The biggest problem is that specific geographic details and settings for these texts are rarely fully explained. Furthermore, the authors themselves were born and educated at various places, as far removed from Italy as Spain, North Africa, and Greece. Although many were probably aware of the Roman Italian way of life, either from first hand experience or through a broad education, we cannot be thoroughly certain of the complete context surrounding each literary work in the absence of explicit details of the author's life and knowledge.

Even the recipes of Apicius contain biases. The version of his famous cookbook available to us today is not the original book, but rather the work of an unknown editor who lived in the late fourth or early fifth century (Flower and Rosenbaum 1958; Vehling 1977). This person supplemented Apicius' gourmet recipes with various recipes for the average middle- and lower-class household in the town and country, which had been collected from some other contemporary and earlier sources (Flower and Rosenbaum 1958: 13; Vehling 1977: 11). Despite these editorial inclusions, the book is still weighted in favour of a gourmet market, judging by the sumptuous nature of most of the dishes. Thus, our knowledge of culinary habits and consumption among the lesser privileged peoples pales in comparison to that of the Roman rich. The bulk of the Roman populace, a great proportion of which was certainly poor, was probably miserably fed on gruel and other porridge-type dishes (Dosi and Schnell 1986; Garnsey 1988a; Guhl and Koner 1989: 501; Tannahill 1988; Vehling 1977: 15).

How far did these texts circulate, and at what speed and scale? Most probably were not read to any great degree outside of Rome. A literary text circulated first amongst the author's circle of friends for comment, before it was disseminated to the general public (Starr 1987). The process was likely slow since each copy had to be hand-written. Some authors recited their works to facilitate the process. Originally, most books passed from friend to friend, a connection which likely confined circulation to fairly elite circles of people (Starr 1987). Bookstores and "public" libraries, which helped broaden the audience, were comparatively late developments (Starr 1987: 213), becoming more important during the first century AD (Starr 1987: 222). However, even here book distribution was conducted on a relatively limited scale. Most copies sold were probably made at the specific request of a customer, while bookshop owners outside of Rome made their own copies to sell to others in their region. There was nothing along the lines of the publishing houses familiar to us today.

We have few details pertaining to the logistics of book-dealing, such as the number of books made, the copying process, pricing, and the circulation of non-current texts. As such, it is difficult to speculate about the size and spatial distribution of the reading audience. A number of practical difficulties such as inconvenience and expense surely inhibited many people from obtaining books. Most literate Romans probably never read any books, but used their knowledge of reading and writing for practical and mundane purposes (Harris 1989: 335). Nevertheless, I suspect that the most popular books, past and present, could have been purchased or commissioned for purchase and distributed over great distances for the right price. Readership outside of Rome amongst any class but the high elite who could afford both a book and the education to read it, therefore, likely remained uncommon. Some works may have circulated more freely than others. Pliny (*NH* 35.2.11) says that Varro is widely read. Horace (*Odes* 2, 30.13 sq.), Propertius (2.7.17), and Ovid (*Trist.* 4.9.21, 4.10.128) boast of a similar universality, while Martial extols his accomplishments (Mart. 6.60), claiming himself to be world renowned (Mart. 11.3, 5.8). The fact that Martial's poems contain references to all types of Romans, from senators to general workmen, presumably added to their mass appeal, and further leads us to conclude that at least his popularity extended beyond Rome (Best 1969: 209-210).

Although there is no way of proving this assumption, I suspect that most information, especially that which pertained to practical matters such as agriculture, was disseminated orally. Literacy coexisted with elements of an oral culture throughout Roman times (Harris 1989: 337). The vast majority of farmers probably never read any agricultural treatise, but some may have heard parts of what Varro, Columella, Palladius, or other authors had written as this information diffused over the empire. It is difficult, if not impossible, to determine how much of this was novel to these farmers. Many likely already practiced the principles contained therein, although again there is no way of verifying this. For some, if not most of them, what the agronomists had written was simply tradition or common sense, and by having their practices verified by these "respected experts" some farmers may have been less inclined to experiment with new techniques, thereby inhibiting development (Harris 1989: 336). Even if the information obtained was new, there is no guarantee that farmers changed their routines accordingly. To them, which animals they kept, raised, herded, and exploited depended heavily upon a complex interaction of physical and sociocultural factors. Animals are physically constrained by geography, climate, and other environmental variables. Optimum living conditions are different for each species, and these in turn may vary from one area to the next. Similarly, sociocultural conditions fluctuate depending on the region, while changing economic schemes and diets can have a profound effect on the role of animals in a culture. Yet, no matter how complex these factors may be, one principle, and a fairly common-sense one at that, generally underlies all aspects of animal use in Roman Italy and resounds among the ancient texts on the subject: maximize gains and minimize losses. "Roman agricultural writing was based from its inception on practical farming experience" (White 1970a: 18); thus, the agronomists are principally concerned with the economic aspects of farming and husbandry, in particular, efficiency and frugality. Whether the farmer raised cattle, horses, sheep, goats, pigs, or other animals, and on what scale, heavily depended on the weighing of all costs and benefits, which in turn were linked with physical and sociocultural factors. However, we must always be aware that our ethnocentric views of what constitutes "sound" weighing of these costs and benefits are not necessarily those shared or practised by the Romans. Religion often acts as a distorting factor, especially when a sacrifice requires a particular animal which concurrently fulfills a valuable role in stock breeding, or might have fetched a high price if sold at the market.[8] Moreover, we have little information to determine how the Romans judged the profitability of their farming enterprises, and are cautioned against loosely extrapolating from modern rationalizing economic theory.[9]

(iii) Reliability

The primary problem with the literary sources concerns their reliability. Williams (1968: 627) comments that "it is always hazardous to argue from literature to real life in the ancient world," but such a procedure is essential to our understanding and reconstruction of the Roman world. How can we judge if all the information detailed represents some form of reality? As in the present, there are many factors which can influence an author's initial purpose in writing a text, and subsequently have a great effect on his/her manuscript as it progresses. There is no simple manner in which to assess reliability of ancient texts. Sometimes general points can be made about the literary genre in which an author writes. For example, at their core, Roman agricultural manuals are essentially "textbooks." In each case, the author assumes the role of instructor while his writing serves to educate or inform the reader about some concept. Appendix 1 groups the principal texts used in this thesis according to literary types or genre, and provides some generalizations about each in terms of the reliability of animal references. It should be appreciated that texts may be categorized in different ways, depending on what aspect is being considered. My listing is based on the animal information each contains.

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[8] There are numerous references in the ancient texts to animals used in religious rituals and sacrificed to deities (see Adkins and Adkins 1994; Corbier 1989; Dumézil 1970; Prieur 1991; Scullard 1981 for more details). Scholars state that much of the meat consumed in the ancient world (at least amongst the urban populace) was from sacrificial animals (MacMullen 1981: 41; Wilkins 1996a: 104). Although I do not deal specifically with the role of animals in religious rituals in this thesis, the topic essentially forms part of a larger analysis of production and consumption. Religious motivation may have been a factor influencing animal production and consumption, but this is impossible to determine at archaeological sites where the context is not ritual or sacrificial in nature. Those sites where the context of deposition may be ritual to some degree are labeled as "special" in this analysis. It is possible that components of the faunal samples recovered from other sites had some ritual connection, but this cannot be determined on the basis of present evidence. Bones from sacrificed animals (which did not differ from other animals in terms of size or other specific physically recognizable features) would be indistinguishable from those of regularly consumed animals, unless the disposal pattern differed for the two groups, which does not appear to be the case at any of these sites (save the "special" cases already noted). If after consumption these bones were tossed into the dump along with other garbage, and not otherwise marked to separate them from the rest of the trash, then there would be no way of discerning their once ritual nature. Prayers, chants, or other ritual behaviours may have preceded animal slaughter and butchery at these "non-special" sites but such actions are invisible in the zooarchaeological data.

[9] There is considerable debate on this topic (e.g., Engels 1990; Finley 1973, 1985; Mickwitz 1937; Morely 1996; de Neeve 1985), and a full discussion is outside the scope of this thesis. I agree with the arguments of Engels (1990: 26-27) and Morely (1996: 73-75) that despite the lack of the "modern" accounting techniques (i.e., specifically, double-entry bookkeeping) in antiquity, Roman farmers were still capable of determining the basic productivity of their agricultural ventures, and could accordingly choose between production strategies on the basis of this information.

Categorizing texts is useful when viewed as a general guide. Pitt (1972) lists categories of historical documents by their source, while Quinn (1979) provides a classification scheme for ancient texts. If anything, such systems highlight the range of textual materials available, and draw attention to the variety in intention, tone, and coverage for each category. The basis behind Roman poetry, for example, is different than that for Roman legal records. Each embodies a different opinion, which affects the way such texts are used to aid archaeological interpretation. "The poet constructs a framework which supplies the setting for his actions or ideas, and the elements of reality will be adapted to suit" (Williams 1968: 577). Thus, in this example, the impression is that poetic references to animals have a greater potential to be embellished or modified for literary sake than those contained in official, and supposedly accurate, legal records.

While general observations about literary genre may help simplify aspects of analysis, they can also be dangerous, since there may be special factors which invalidate them in the case of individual authors. Ideally, the reliability of the information presented in the ancient texts can really only be assessed on an individual, case by case basis. It depends on so many factors such as the education and social status of the authors, their context in time and space, their knowledge, life experiences and purpose in writing, the presumed readership, and the degree to which they appear to be innovating or repeating information. Biographical information about most of the ancient authors is detailed elsewhere (e.g., *Oxford Companion to Classical Literature*) and will not be repeated here. Moreover, an analysis of the context for each of the ancient texts is a huge and extremely controversial task, which cannot be dealt with fully in this thesis.

Recognizing the dangers associated with generalizing about the reliability of the information presented in the various genres of texts, as well as the complications involved in contextualizing each work, I wish to comment briefly on the nature of the animal references found in the principal types of texts used in this thesis. I stress that these reflections are only meant as a general guide. Exceptions will always apply, and the degree to which some texts break from these standards will vary considerably. For some the whole work may form an exception, while in others it may simply be a small passage or line within. There is no easy method of determining these exceptions short of performing detailed contextual analyses for each word and phrase in all of these ancient texts, a clearly formidable, if not impossible assignment.

Overall, I judge most animal information which is recorded in official documentation such as Roman inscriptions and legal texts to be reliable. Inscriptions can come in a variety of forms, such as commemorative plaques, dedications, epitaphs, military diplomas, public notices, and even graffiti. Animal references found amongst the hundreds of thousands of Roman inscriptions documented, although relatively rare, can presumably be accepted as a fairly trustworthy record. One may wish to embellish or taint the reputations of the human subjects written about in the inscriptions, but it seems unlikely that such a practice would be carried over to misrepresent any of the animals mentioned as well. Roman inscriptions, therefore, may be taken as a reliable but very uncommon source of animal information.

Legal documents and religious writings constitute a second category. These records have a specific use, and because of their nature should be free of false or exaggerated details. True facts are vital. Legal and religious recordings thus have the potential to provide reliable pieces of information about animals, and many of them do. However, the context is generally limited to aspects which relate either to religious aspects, such as animal sacrifice, or to legal aspects, such as prices for certain stock or trade in animal resources. While legal documents are invaluable for determining key features of the Roman economy, it is unfortunate that only a few of these which contain any references to animals survive for Roman Italy. Roman legal documents and religious recordings, therefore, are a reliable, but restricted, source of animal information.

The agricultural manuals of Cato, Varro, Columella, and Palladius; the encyclopedic volumes of Pliny the Elder, Aelian, and Strabo; Celsus' scientific poetic manual on medicine; and even Apicius' cookbook are all examples of a "textbook" style of Roman writing. Each serves some purpose to instruct or educate the reader on a particular topic or concept, even if the method of presenting this information differs among them. In attempting to establish the reliability of these works it is important to understand that this depends heavily on the skill, knowledge, and critical acumen of the ancient author, and not on what has been proven or documented since his time. Thus, what we might now consider imprecise or fanciful information might have been widely accepted as fact during Roman times.[10] Presumably, most of the ancient audience expected accurate details from respectable authors such as the agronomists; therefore, the information they furnish about animals can be taken as a true recording. Whether or not this information can be generalized outside of the author's personal context, however, is a different matter. The agronomists generally detail actions required to operate the ideal farm, which while ideal, might not have been realistically feasible for all Roman farmers. Nevertheless, these manuals are still quite practical in their agenda and can be regarded as reliable sources of information on at least the model or ideal role of animals in the contemporary Roman society.

The comedies of Plautus and Terence make mention of animals and food in their dialogue, much of which is presumably based on actual events and contemporary practices. Most passages which mention food and animals in Roman comedies are incidental in nature and, as part of the background, considered to mirror accuracy to some degree. Nevertheless, it is still important to determine the context for each reference in order to extrapolate to any sort of reality.

Roman elegies and epigrams frequently mention animals, especially in relation to food, animal sacrifice, natural settings, and animal analogies for characters. Stripped of their poetic decoration, these references, especially notes about sacrifice and food, report presumably contemporary and accurate aspects about the role of animals in Roman life. Thus, with selective caution, animal representations amongst Roman elegies and epigrams can be regarded as reliable.

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[10] For example, the Romans believed (and the agronomists reported) that the qualities of the male mating animal solely determined the characteristics of its progeny. They were unaware of the principles of genetics, as were most people until the early 20th century.

Bucolic or pastoral poetry, such as Virgil's *Eclogues* and Calpurnius' *Eclogues*, is rich in animal references. These poems generally idealize country life as they portray scenes of shepherds and other rural folk at work. Although this world is stylized in the pastoral poetry, it is nonetheless based on some realistic contemporary world. Animals are normally secondary characters in the poems, and as such are generally portrayed in a relatively authentic manner compared to often embellished representations of humans or landscapes. Therefore, pastoral poetry contributes reasonably accurate information about animals during Roman times, and with appropriate prudence can be viewed upon as a reliable resource.

The hunting poetry of Grattius and Nemesianus is also rich in animal references, but by the nature of its title this information is usually restricted to that specific context. They provide details about animals used for hunting, such as dogs and horses, as well as those wild animals hunted. While the focus varies from description to instruction depending on the work and context, hunting poetry generally presents reliable information, but this must be filtered through the poetic elaborations which may be associated with each.

Didactic poetry (e.g., Virgil's *Georgics*, Macrobius' *Saturnalia*, and Lucretius' *De rerum natura*) is similar to the 'textbook' style noted above in that it too is intended to give instruction and disseminate information. However, didactic poetry differs in that this practical, instructional objective is in some measure overshadowed by a need to create a literary 'experience' for the reader. It is easier to embellish details in didactic poetry as opposed to paraliterature (for the sake of poetic license), but the reader still expects a foundation of veracity and accuracy. Any animal references contained in these works, therefore, should have some degree of truth to them. Consequently, didactic poetry is a fairly reliable source of animal information.

Roman letters include those written for publication as well as those not originally intended for publication but which have been preserved in some manner. By their very nature we expect letters to disclose veritable news and communicate accurate facts and details. Of course, this is not to say that letters are devoid of exaggeration and suppression of these details, but rather that there is some truth to their basis. The amount of truth depends on a variety of factors including the author's personality, the significance of the matter discussed, the type of audience, and the author's anticipation of the reaction from that audience (an author may suppress certain details if he knows they might markedly upset the reader). We might expect greater accuracy of details in letters to friends, a familiar group, but also in business correspondence, especially that addressed to a superior figure, where penalties or conflicts might ensue in the event of falsified or exaggerated information. These are the principal types of Roman letters available, therefore each can be relied upon as an accurate source of animal information. Unfortunately, the animal references amongst Roman letters, although reliable, are also generally scarce.

Novels were quite rare compared to other Roman literary works. One example, the *Satyricon* of Petronius, although partly a parody of other novels, contains numerous references to food. While some of these are obviously highly exaggerated depictions, they are based nonetheless on some less grandiose truth. Peeling off the embellishments can produce a more reliable picture.

Roman satires contain a wealth of information about animal resources, diets, and rural and urban life, and as such might be used as a meaningful source. However, they largely consist of the presentation of extremes: exaggeration of the shocking and suppression of the mundane elements of life. In order to use satire as a reliable medium, therefore, effective compensation is required. The reader must be aware of the audience, the moral message(s) in the satire, and any hidden symbolism given to the various references before he or she can extrapolate the reality behind the extremes presented by the satirist.

While Roman texts supply a huge database of animal references which can assist in reconstructing the role of mammals in the ancient economy and diet, it is always important to be aware of the biases and limitations associated with their analysis. Nevertheless, when combined these references cover a broad range of topics related to the production and consumption of animals in Roman Italy and become an invaluable source of information. However, they are but one set of data. Zooarchaeological evidence is another.

Chapter 2

BACKGROUND TO ZOOARCHAEOLOGY

My primary focus in this dissertation is the zooarchaeological data. This chapter provides background information about this discipline by outlining its development and history and discussing what it can accomplish. Animal bones yield data about a variety of topics—species and skeletal elements represented, age and sex, pathologies, butchery, and burial conditions, to mention just several—which in turn aid in our reconstruction of ancient economies and diets. Although not without their own biases, animal bones offer a direct link to past action. Essentially, they represent the disposal of materials from meals, butchery, sacrifice, burial, or some other activity.

Development of Zooarchaeology

Zooarchaeology is a fairly new branch of archaeological research that has undergone much development since its inception. Although some researchers were noting the presence of ancient bones as far back as the sixteenth century, the origins of zooarchaeology might best be traced back to the early nineteenth century, when people began to question the authenticity of the orthodox Biblical narrative of Creation, in light of increased discovery of fossil and archaeological bones in Europe. Originally, these finds were treated with skepticism, and, if not simply ignored, were somehow explained away by one means or another, the usual theory involving some mention of the great Flood, and the mixing of remains it produced.

It was not until the mid-nineteenth century that zooarchaeology first began to contribute important data to scientific inquiry. Bones of extinct animals in undisturbed association with lithic remains from prehistoric humans assisted geologists and other scientists such as Charles Lyell, Lord Kelvin, Thomas Huxley and Charles Darwin in reshaping the understanding of the great age of the earth and of the processes of evolution. Zooarchaeological data, therefore, were instrumental in providing proof of the antiquity of humans. The next step was to order these remains into some kind of chronology. General efforts saw antiquaries like Christan Jurgensen Thomsen and J.J.A. Worsaae establishing sequences of archaeological periods based on artifacts. However, others, such as the paleontologist, Edouard Lartet (1801-71), proved that ordering of the past could also be done effectively by grouping strata according to their associated animal remains. He recognized four periods: (1) cave bear period, (2) woolly mammoth and rhinoceros period, (3) reindeer period and (4) aurochs and bison period (Daniel 1975; Davis 1987).

Once a chronological framework had been established in archaeology, the contribution of faunal remains in archaeological research shifted. By the 1870s, bones were being studied for the information they might yield about early human behaviour and economy. It was a major breakthrough when animal bones were no longer considered trivial objects. Rather, archaeologists asserted the importance of careful excavation and recovery of all materials. This breakthrough facilitated further specialized studies of archaeological animal bones. In

1862, a Swiss researcher, L. Rütimeyer, initiated investigation into the origins of domestication by distinguishing between bones of domestic animals and their wild ancestors at a Neolithic site in Switzerland (Davis 1987: 21). Thirty years later, another Swiss researcher, J. Ulrich Duerst, claimed to be able to show that the bones of wild cattle and sheep were reduced in size and of a different texture compared to the bones of their domestic counterparts (Duerst 1908; Davis 1987: 21). The osteological investigation of domestication has subsequently been a major topic in zooarchaeological research, particularly since the early and middle part of the twentieth century when archaeologists became interested in the origins of food production.

Following the emphasis on chronology and domestication, the third zooarchaeological topic to receive attention was the use of faunal remains to reconstruct past environments. Dorothea Bate (1937) was probably the first to use zooarchaeological data to infer climatic changes when she plotted the frequencies of two wild animals (fallow deer and gazelle) in different strata of the Mount Carmel caves in Israel. Each animal was characteristic of a different habitat. Moreover, her study also was one of the first to use quantitative zooarchaeological data.

The 1950s and 1960s saw an increased interest in zooarchaeological remains. During this time much research was conducted by German scholars of the "Munich school" under the guidance of Joachim Böessneck. These individuals studied, in great detail, the faunal remains from European and Near Eastern archaeological sites, and contributed significantly to our understanding of the osteology of domestic livestock and to basic zooarchaeological methodology. In North America, researchers such as Stanley Olsen (1951) made significant contributions to animal bone analysis through their faunal reports and skeletal manuals. Other North American scholars like Struever (1968) and Thomas (1969) advanced our understanding of zooarchaeological quantification and recovery biases.

Zooarchaeology developed further in the 1970s, no doubt due to the increased emphasis on more scientific and experimental procedures in archaeological research that was advocated by new theoretical approaches such as "Processual Archaeology." Zooarchaeologists were thus encouraged to collect quantitative and qualitative data in order to test hypotheses about the role of animals in both present and past societies, to decipher the depositional context of animal remains, and to understand the post-depositional forces which acted upon those remains.

The momentum of the 1970s has continued into the 1980s and 1990s. The implementation and augmented use of models and theoretical frameworks, coupled with the active desire to solve methodological problems, has made zooarchaeology an important subdiscipline of archaeology today. The database of faunal materials in some areas, such as England, is immense, while that in other areas is steadily growing. Data collection remains essential to expand our zooarchaeological collection for the future comparative study of animal bones from sites.

Methods of Analysis

There has been much emphasis over the last few decades on the information animal bones can reveal about both the natural and cultural world of the past. This increasing attention, has, in turn, sparked a need to identify and standardize a methodology for the recovery and study of these remains (Chaplin 1971; Grigson 1978; Lawrence 1973). In this section, I outline the basic procedures involved in the recovery of animal bone from archaeological sites, and the methods employed in their subsequent identification and study.

Recovery

Since obtaining quantitative data is vital to zooarchaeological research, it becomes necessary to understand the processes which generate such data, that is, the method of recovery of the bones. Not all faunal remains from archaeological sites are recovered in a similar manner. Archaeologists may retrieve bones manually during trowelling in the trenches, or collect them using dry and/or wet sieving. Considerable debate exists about the efficacy of each of these methods (Barker 1975; Casteel 1972; Clason and Prummel 1977; Dye and Moore 1978; Gordon 1993; Grayson 1984; Levitan 1982; Maltby 1985; Payne 1972, 1975, 1992; Schaffer 1992, 1994; Steele 1983; Struever 1968; Thomas 1969; Watson 1972). Generally, zooarchaeologists assert that trench recovery favours the collection of bigger and easily recognizable pieces, such as long bones from large animals. This can bias the sample and taint any conclusions drawn from it. Screening, although more time-consuming than manual recovery in the trench, facilitates the retrieval of smaller bone pieces in addition to the larger ones. As such, it reduces the biases inherent in simple trench recovery and generates a faunal sample which is probably more representative of the original deposit of bones. Wet-sieving using fine-meshed screens is perhaps the best method since the water washes the soil matrix from the bones, thereby rendering them more visible. This is especially important in the recovery of tiny faunal remains such as rodent bones, small teeth, and fish bones (for fish see Brinkhuizen and Clason 1986; Jones 1982).

Determining when to employ screens or wet-sieves at an archaeological site, and deciding what deposits or proportions thereof should undergo such treatment depends upon the research goals of the project, themselves contingent on financial, spatial, temporal, methodological or other constraints. In those excavations that have employed screens or sieves, generally only selected samples have been subjected to these intensive procedures. Excavators normally choose to sieve those deposits with the greatest potential to yield many and/or special bone pieces. Such selective procedures can introduce potential biases which must be compensated for if materials and sites are to be compared.

Taphonomy

Once the faunal sample has been recovered, factors affecting bone preservation and survival must be considered. Although "taphonomy" was originally defined as the study of the transition of animal remains from the biosphere, or living realm, to the lithosphere, or fossil realm (Efremov 1940), the goals of most taphonomic research in zooarchaeology today are to determine what natural and cultural processes have modified particular bone assemblages and to understand issues of site formation so that accurate reconstructions of the original faunal assemblage can be formulated. The field has grown considerably over the last few decades as scholars augment and refine our knowledge of these multifarious processes through experimental research (Andrews 1995; Behrensmeyer 1978, 1988; Greenfield 1988; Jones 1986; Lyman 1994a; Nicolson 1992, 1998; Payne and Munson 1985; Pearce and Luff 1994; among others).

The taphonomic processes which act upon bones can be subdivided into two main categories: natural and cultural. Natural processes include any geological or biological factor, such as the weathering of bone from exposure to wind or water, chemical actions in the soil, discolouration and etching resulting from contact with plant roots, or gnawing by rodents, carnivores or other animals. Cultural processes include activities such as butchery, cooking, or any other action where humans either directly or indirectly modify the bone. Although cultural processes are technically a subcomponent of taphonomy, often each is considered as a topic in its own right (e.g., butchery, cooking, bone-working, etc.), generally for the information it yields about human behaviour and activity. Thus, in many instances "taphonomy" is reduced to a study principally of the geological and biological factors affecting an assemblage.

One taphonomic variable which has received much attention, and which is of great importance for Roman period sites in Italy, is carnivore gnawing. Damage to bone by carnivores can range from little to total destruction of elements and assemblages (Binford 1981; Brain 1976, 1981; Haynes 1980, 1981, 1982, 1983; Lyman 1994a; Marean and Spencer 1991; Payne and Munson 1985; Stallibrass 1990; among others). Typically, greater destruction occurs at the ends of long bones where cancellous tissue is concentrated, and among the smaller bones which are worth crunching, while survival is probably better for bones that are both large and strong, or too small and not worth the effort involved (Payne and Munson 1985). Bones also tend to be damaged to a higher degree when they are chewed on at carnivore denning locations, as opposed to retrieval or kill sites (Binford 1981; Haynes 1982). Finally, although dogs may uproot buried bones, the presence of carnivore marks generally indicates that the bones had been unburied for some period of time.

Identification

Reliable comparative analyses of bone samples require accurate identification of faunal remains. Zooarchaeologists generally identify bone pieces to element and side, and taxonomic family, genus, or species, where possible, with the aid of comparative osteological collections, keys, and "bone-atlases,"[11] and with a firm knowledge of basic anatomical characteristics of animal bones. Generally, zooarchaeologists are fairly proficient at identifying, to a species level, complete or nearly whole bones, ends of bones, teeth, and any other fragment with some diagnostic feature. Although few skeletal reference materials exist for the comparison of animal bones retrieved from archaeological sites of the distant past which contain extinct species, collections are normally good enough to allow for correct identification of animal bones collected from sites post-dating the period of animal domestication. Apart from possible changes in size, these animals are thought to resemble fairly closely their modern day descendants, which make up the bulk of the skeletons prepared for comparative collections (Davis 1987). Although animals are constantly evolving, gross morphological changes in their bones usually take many millennia to occur. Thus, it is important for my research that the general consensus among zooarchaeologists is that the osteology of Roman period animals basically parallels that of modern-day species.

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[11] There are a number of these aids, including Amorosi 1989; Barone 1976; Böessneck 1969; Böessneck, Müller and Teichert 1964; Brainerd 1939; Brown and Gustafson 1979; Cant 1976; Clutton-Brock et al. 1990; Cohen and Serjeantson 1986; Cornwall 1956; Gilbert 1980; Gilbert, Smith and Savage 1981; Hildebrand 1954; Hillson 1990, 1992; Kratochvíl 1969, 1973; Olsen 1951; Pales and Garcia 1981; Pales and Lambert 1971; Payne 1985; Prummel 1987a, 1987b, 1989; Prummel and Frisch 1986; Schmid 1972.

Even with the best of comparative collections, some bone fragments are more identifiable than others, and often the zooarchaeologist must limit the amount of time involved in attempting to identify each bone piece to a particular species. In many cases, fragments of ribs and vertebrae cannot be assigned to species, but can still be counted, perhaps as part of a group such as large-sized mammal, medium-sized mammal, etc. A similar procedure might be followed for other unidentifiable splinters of long bones, or other fragmentary material.

Quantification

The initial stage of a faunal analysis is to quantify the already identified and catalogued bones. In recent years much attention has been given to methods of quantifying faunal remains. Reviews of the variety of systems abound (e.g., Chase and Hagaman 1986-1987; Gautier 1984; Grayson 1979, 1984; Klein and Cruz-Uribe 1984; Lyman 1994b; Perkins 1973; Rackham 1983; Ringrose 1993). There is much variability, in both terminology and meaning. Lyman (1994b) listed 112 terms used in zooarchaeological quantification which combined had 122 distinct definitions. Of all these quantifiers, the Number of Identifiable Specimens (NISP) and Minimum Number of Individuals (MNI) figure most prominently amongst zooarchaeological reports. Practically every zooarchaeological analysis contains NISP statistics, while a great many of these relate MNI values as well. The popularity of NISP and MNI counts, therefore, facilitates comparisons amongst zooarchaeological data from different sites. Other methods such as the Relative Frequency (abbreviated RF: Chase and Hagaman 1986-1987; Gilbert and Singer 1982; Gilbert, Singer and Perkins 1981; Perkins 1964), or those based on systems of weighing (Casteel 1978; Kubasiewicz 1956), have been infrequently applied in the analysis of faunal remains and thus have a more limited value in site comparison.

The NISP is the total number of elements of each species or taxonomic group that can be identified in the faunal sample, regardless of side, age, and sex. It is simply a count of the number of fragments of each taxon's element of study in the sample. There are many problems with this method (which are discussed in Grayson 1979, 1984; Klein and Cruz-Uribe 1984). In general, NISP values are particularly vulnerable to the effects of fragmentation in the sample, which are different for each animal and site. Fragments are usually ignored or treated as whole bones. Since its calculation does not discriminate between the bones of the same or a different carcass, the same animal could easily be counted several times, and the NISP may well exceed the actual number of individuals considerably. NISP also automatically weights a species according to the number of quantifiable bones in its skeleton. Animals with more identifiable parts will usually be over-represented in relation to other animals with fewer identifiable parts (Daly 1969). Furthermore, it gives larger values for taxa deposited whole on the site than for those butchered elsewhere and reaching the site in parts. Finally, NISP can be affected by different collection techniques. Screens catch smaller bones which can dramatically inflate NISP figures.

Despite these problems, NISP remains a popular quantifier for several reasons. First, it is relatively easy to calculate.[12] Second, it holds a fairly uniform meaning, although Lyman (1994b) notes some ambiguity in the term "identified." Typically, "identified" means "identified to taxon," but it can also mean "identified to skeletal element," and a distinction should be made. Finally, NISP may be an adequate measure for demonstrating broad patterns in the assemblage profile (Winder 1991: 116).

The MNI calculation is a raw count of the number of individuals necessary to account for all the identifiable bones (Klein and Cruz-Uribe 1984). Often it takes into account information on the age and sex of the animals, in order to categorize individuals as accurately as possible and avoid unnecessary overestimation (often the case with NISP) or underestimation (often the case with MNI's that do not use age and sex subcategories) of species. Various modifications of the MNI method have been proposed over the years (Binford 1978, 1981, 1984, 1988; Bökönyi 1970; Casteel 1977a, 1977b; Chaplin 1971; Clason 1972; Fieller and Turner 1982; Grayson 1973, 1978, 1979; Krantz 1968; Perkins 1973; Poplin 1976; Uerpmann 1973a, 1973b; Wild and Nichol 1983; Winder 1991; Ziegler 1965).

The assumption is that MNI numbers better reflect original kill ratios than do NISP calculations. However, they are not devoid of bias. First, MNI is unable to distinguish between animals represented by joints of meat rather than whole carcasses, or whether animals are collected for industrial purposes (Grant 1975). Second, any count of a particular bone that has, as a result of taphonomic factors, been artificially increased relative to other less biased bones will skew MNI numbers (Gilbert and Singer 1982: 32). Furthermore, MNI counts are subject to the problem of aggregation, in that they vary depending on how the faunal material from a given site is divided into smaller aggregates, based on temporal or spatial factors (Grayson 1984: 29).

Binford (1978, 1981, 1984) substitutes Minimum Number of Elements (MNE) and Minimum Animal Units (MAU) for NISP and MNI calculations. These are related to the other quantifying methods. However, "they are specifically designed for the study of skeletal part representation, rather than taxonomic abundance *per se* " (Ringrose 1993: 129). The MNE is simply the NISP calculated for each skeletal part. The difference is that an attempt is made to match fragments in order to minimize the chance of counting the same bone (or bone-part) twice. In this way, MNE allows for fragmentation, while NISP does not. The MAU is a normed version of the MNE. It is obtained by dividing the MNE by the number of times that skeletal part occurs in living animals, for example 2 in the case of paired elements (right and left side), or 4 in the case of metapodials (right and left, front and back legs).

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[12] Although this may be done in different ways. For example, some zooarchaeologists count each individual tooth in a mandible or maxilla as a single element (e.g., Albarella's [1993] NISP2 count), others prefer to count the whole element (i.e., mandible/maxilla plus associated teeth in it) as "one" (Chaplin 1971). Some include ribs and vertebrae in NISP counts; others exclude them.

Another modification of the MNI incorporates principles derived from the Lincoln (or Peterson) index and is described more fully elsewhere (Fieller and Turner 1982; Krantz 1968; Poplin 1976; Turner and Fieller 1985; Wild and Nichol 1983; Winder 1991). This method proposes that *LR*/*P* (*L* = number of left sides, *R* = number of right sides, *P* = number of pairs) is an estimate of the number of animals in the "Death Assemblage" (Ringrose 1993: 128). For example, multiplying the number of right humeri by the number of left humeri and dividing this by the number of humeri determined to be left/right pairs from a single animal yields the best estimate of the number of animals which had died. In theory this method offers the best estimate of the actual number of animals comprising a faunal assemblage, but in practice this method contains many biases. The multiplicative nature of it means that it is more vulnerable than other methods to any kind of mis-identification, especially in pairing and fragmentation (Ringrose 1993: 129). Transport of elements to and from the site presents further complications. Finally, the method can become highly complicated mathematically (Winder 1991), and thus is generally avoided. It still remains to become widely accepted, and has yet to be reported in Roman zooarchaeology.

Much discussion of the merits and shortcomings of all of the zooarchaeological quantifiers is available (see Lyman 1994b for a more complete listing). The fact remains that NISP and MNI are by far the most universally practiced and popular of all the methods. Klein and Cruz-Uribe (1984: 37) and Crabtree (1990: 160) advocate this combination as a good solution to the dilemma of NISP and MNI individual plots. Moreover, when used in conjunction, NISP and MNI generally provide a good indication of species/taxa abundance in faunal analyses. In this manner, therefore, it is possible to obtain a clearer picture of the relative contribution of the taxa represented which in turn will reflect and approximate the actual representation of the taxa in the economy and diet of Roman Italy.

Age and Sex

Once the element, side, and species or taxonomic category have been established, the zooarchaeologist can seek information about the sex of the animal, and its age at death. These data help the researcher determine demographic characteristics of the animals killed, which can reveal much about the economy of the culture in question.

There are basically two methods for age estimation: (a) juvenile-adult distinction (epiphyseal fusion; deciduous-permanent dentition) and (b) continuous distinction (dental age-classes). The phenomenon of epiphyseal fusion works on the principle that as an animal matures the epiphyseal ends of long bones in its body fuse to their diaphyseal shafts, thereby arresting the growth of the bone in length. This fusion occurs in different bones at different ages, some around birth, most by the end of the juvenile period, and others still later in the animal's life. The sequence and timing of fusion has been studied for many domestic and wild animals (Amorosi 1989; Bull and Payne 1982; Bullock and Rackham 1982; Bruni and Zimmerl 1951; Garcia-Gonzalez 1981; Grigson 1982a;

Habermehl 1961; Hatting 1983; Lesbre 1897; Moran and O'Connor 1994; Morris 1972; Myers and Emmerson 1966; Noddle 1974, 1984; Schmid 1972; Silver 1969; Sisson and Grossman 1966; Smith 1956, 1966; Todd and Todd 1938; Watson 1978) but for others these are still unknown.

Most mammals go through two sets of dentition in their lives: deciduous and permanent. Deciduous (or baby) teeth erupt at early ages and are subsequently replaced by permanent teeth later in life. As in the case of epiphyseal fusion, the sequence and timing of the eruption of deciduous teeth and their replacement by erupting permanent teeth is fairly standard for most animal species, and has been studied and recorded (Andrews 1973, 1982; Beasley, Brown, and Legge 1987; Brown 1949; Bull and Payne 1982; Bullock and Rackham 1982; Deniz and Payne 1982; Ewbanks et al. 1964; Grigson 1982a; Matschke 1967; Moran and O'Connor 1994; Morris 1972; Noddle 1974; Schmid 1972; Silver 1969; Sisson and Grossman 1966). Thus, zooarchaeologists can obtain an idea of the relative frequency of juvenile and adult individuals by counting the number of deciduous and permanent teeth recovered.

In order to refine these age categories, zooarchaeologists have studied the wear patterns on the teeth (Aitken 1975; Carter 1975; Deniz and Payne 1982; Grant 1975, 1978, 1982; Payne 1973, 1987) The basic premise is that teeth become increasingly worn with age. An older animal has subjected its teeth to more stress over the years than has a younger animal with a more recently erupted dentition. Various intermediate stages can be categorized based on the pattern and/or degree of wear on the teeth. Several researchers have developed age stages for cattle, sheep/goat and pigs, on the basis of the sequence of eruption and degree of wear on the occlusal surface of the mandibular teeth (Payne 1973, 1987; Grant 1975, 1978, 1982), while others have based their systems on the height of the tooth crown (Carter 1975; Klein et al. 1981; Klein, Allwarden, and Wolf 1983; Levine 1982). In animals with high-crowned teeth whose roots are closed, such as bovids and equids, teeth wear from the top to the root, and therefore the shorter the crown height is, the older the animal.

There are two principal problems inherent in these systems of age estimation. First, even within the same species, individual and populational variability inhibits specificity of results. There are always slight individual differences in the timing of dental eruption, the pattern and rate of wear, and the fusion of epiphyses due to natural variation, and separate populations of the same species may differ markedly due to genetic or environmental variation (Barnicoat and Hall 1960; Rackham 1994; Silver 1969; Wiener and Purser 1954). Tooth wear, for example, varies not just with an animal's age, but also its diet. Coarse, hard or gritty foods will cause teeth to wear at a much faster rate than will softer foods. In light of the numerous sources of variation affecting the animal population, therefore, it is important to note that the ages of archeological specimens based on modern examples should always be considered approximate.

A second problem is that, unless a complete skeleton is present, it is impossible to determine precisely the exact age or developmental stage of the animal when it died. This being rarely the case, zooarchaeologists often must estimate ages using broadly discrete markers such as "juvenile" or "adult," without a means of determining exactly how "young" or "old" the individual was.

The determination of sex from animal bones is based on sexually dimorphic characteristics such as different shapes sizes and expressions of features in the male or female of a species (Armitage and Clutton-Brock 1976; Driver 1982; Grigson 1982a&b; Hatting 1983; Prummel and Frisch 1986; Sadler 1991; West 1982, 1990). Male and female pig canine teeth, for example, are noticeably dimorphic. Similarly, canine teeth are frequently present in male equids, but absent in females, and, with the exception of reindeer, only male deer carry antlers. Finally, the shape of the skull and of the pelvic bone in many animals sometimes provides clues to an animal's sex (Prummel and Frisch 1986; West 1990).

Sexual dimorphism is commonly used to separate males and females (Higham 1969; Howard 1963). Generally, males of a species are bigger than females. This is reflected in their bones, which are larger and more robust. In some animals the size difference is so great that the sex of the animal to which the individual bones belonged can be inferred with certainty. Two problems, however, complicate the accuracy of sex determination. First, there is usually a range of overlap between the sexes in bone measurements. Larger female individuals may have bones of similar size to smaller males of the same species. Secondly, castration can complicate the picture by mixing typically male and female characteristics, and blurring the size boundary between the two (Figdor 1927; Hatting 1975, 1983).

Pathology

Certain pathological conditions can leave traces on animal bones. Recognizing and documenting these conditions assists in reconstructing the general state of health or specific cause of death amongst individuals and population of animals (Baker 1984; Baker and Brothwell 1980; Levitan 1985; Siegel 1976). In some cases, the condition is unique, such as a fractured bone either deliberately or accidentally inflicted. This might help reconstruct living conditions for the animal, or provide information about how it was treated. In other cases, the pathological disorder might be more widespread through a population of animals, which suggests chronic illness, or perhaps even an epidemic. Animal pathologies that affect bones can be broken down into eight broad categories:

(1) Abnormalities of development - such as fusion of toes, or increase/decrease in skeletal elements (e.g., extra toes, absence of tooth)
(2) Metabolic disorders of bone - e.g., osteoporosis, osteomalacia
(3) Hormonal influences - retardation or acceleration of growth
(4) Inflammation, infection, and necrosis of bone
(5) Traumatic injuries - e.g., fractures
(6) Neoplasia and similar conditions
(7) Diseases of the joint - e.g., osteoarthritis causing eburnation and/or extoses
(8) Oral pathology - e.g., malocclusion, caries, abnormal wear, ante-mortem tooth loss, calculus, periodontal disease, abcess development

Of these, pathologies affecting the teeth and joints seem to be the most common.

Measurements

The measurement of animal bones is often performed with calipers and measuring boxes, following standardized landmarks and measurement procedures such as those outlined by von den Driesch (1976), Morales and Rosenlund (1979), and Payne and Bull (1988). It is important on several counts. First, measurements of individual bones allow researchers to predict overall animal size, most commonly withers height (Böessneck 1956; von den Driesch and Böessneck 1974; Fock 1966; Godynicki 1965; Harcourt 1974; Kiessewalter 1888; Koudelka 1885; Matolcsi 1970; Teichert 1969, 1975; Vitt 1952; van Wijngaarden-Bakker and Bergström 1988; Zalkin 1960). Second, measurements allow the researcher to note size variation among different species or breeds (e.g., sheep versus goat, or domestic pig versus wild boar) and thus assist with identification (Böessneck 1969; Böessneck, Müller, and Teichert 1964; Eisenmann 1981; Grigson 1969; Hammond 1932a; Higham 1969; Kratochvíl 1973; Noddle 1982; Payne 1969, 1985; Payne and Bull 1988). Third, measurement data can help distinguish between sexes and among age categories within a single species (Bartosiewicz 1984; Bartosiewicz, Van Neer and Lentacker 1993; Beasley, Brown and Legge 1993; Bosold 1968; Dottrens 1946; Higham 1966; Howard 1963; Thomas 1988; Zalkin 1960). Finally, the data, when plotted on a graph, becomes a marker of populational variation. From this plot, the researcher may determine minimum, maximum, and average size, as well as the range of values, while the shape of the plot provides clues about the distribution of measures (Thomas 1989).

Topics of Study

A principal goal of zooarchaeological analysis is to use all of the data (i.e., taxa represented, quantification of species and elements, age, sex, pathologies, measurements, taphonomy) accumulated from the faunal sample retrieved at an archaeological site to reconstruct animal individuals and populations. Such reconstructions, in turn, allow us to determine aspects of the natural and cultural world associated with these animals. The subjects investigated in zooarchaeology might be broken down into the following topics, here organized under two broad headings: (i) those pertaining to the **natural** world; (ii) those with a **cultural** component.

(i) Natural

Climate and Environmental Reconstruction

Animals generally prefer certain habitats in which to live, be it woodland, grassland, or other environments, and have evolved physiological and behavioural adaptations to these. Thus, it should be possible to determine the physical environment at a site from the presence and relative frequency of animal species recovered. Some species, including many domestic animals, can adapt to a fairly broad range of ecological conditions, and therefore are of limited value in environmental reconstruction. Other species, in particular many rodents, microfauna, and a variety of birds, can only survive in fairly restricted habitats. Thus, the zooarchaeologist can easily determine ecological conditions at a site if he or she is armed with the knowledge of their ecological preferences from the presence of such species.

Climatic conditions can be reconstructed in a similar manner. Characteristic species inhabit arctic, temperate, and tropical climates. Their presence in archaeological deposits indicates what conditions prevailed during that time. Additional climatic information may be obtained from an analysis of animal size. The Bergmann effect documents that individuals of many species (or groups of related species) of mammals and birds tend to be larger in colder climates and smaller in warmer climates. Discrepancy in bone measurements from a single species, therefore, might point to climatic variations. Caution is required, however. There are numerous exceptions to the Bergmann effect. Mayr (1956) notes that it is only one of several strategies whereby an animal can adapt to different climatic regimes. Moreover, other factors, such as food availability, also influence body size, while the considerable range of sizes occupied by domestic animals, primarily due to the great variation in livestock breeding practices, inhibits their use in this capacity.

Seasonality

Many activities of animals are seasonal in character. Mating, migration, and birth often occur during specific seasons, while the cycle of feeding and the availability of food are also seasonal in many parts of the world. Food is normally scarce during the winter, so an animal's growth slows at this time. On the other hand, growth accelerates during the spring and summer when climatic conditions are more favourable and much food is available.

In many cases, an animal's bones reflect these seasonal changes. For example, female birds build up calcium deposits in their long bones before they lay eggs, so that they can access this to form eggshells (Driver 1982; Rick 1975). Deer develop antlers before mating in springtime and shed these during autumn. Finally, some bones and teeth leave annual marks or bands on the surface which indicate an alternating pattern of rapid spring-summer growth, and reduced autumn-winter growth (Adams and Watkins 1967; Aitken 1975; Borque, Morris and Spiess 1978; Casteel 1976; Gorden 1982; Stallibrass 1982). Counting these bands further allows the researcher to tabulate the age of the animal (Coy, Jones, and Turner 1982; Erickson and Seliger 1969; Gilbert 1966; Low and Cowan 1963; Mitchell 1967; Saxon and Higham 1968; Stallibrass 1982). Since these bands are contingent on seasonal variability in food resources, they may be difficult to detect in domestic species maintained and fed year round.

Patterns of animal age at the time of death may also help indicate seasonality (Davis 1983; Higgs and White 1963; Legge and Rowley-Conwy 1988; Legge, Williams, and Williams 1991; Payne 1973). If the researcher has a good idea of the mating schedule of the species, then he/she might predict the season of death from the age estimates of the animals recovered. For example, a great collection of butchered newborn pigs retrieved from an archaeological site where it was known that pigs bred once a year and gave birth during late-summer, fixes the season as such for this particular slaughtering episode, assuming there has been no movement of goods.

Finally, the presence or absence of migratory animals amongst the faunal materials can indicate the season. This is especially evident in the case of migratory birds which occupy sometimes very distant lands during different seasons.

(ii) Cultural

Animal Husbandry

The patterning evident in the relative frequency, and age and sex composition of the various animal taxa represented at a site, coupled with data about seasonality, domestication, size and pathologies, can yield information about animal husbandry practices. Animals may be exploited for their primary and non-renewable resources such as meat and hides/skins, but, depending on the species, can contribute secondary products such as milk, wool, hair, and manure to an economy. In addition, some animals perform tasks, such as carrying supplies or humans, pulling the plough, drawing carts and wagons, guarding flocks or homesteads, chasing hunted game, or catching vermin around the house. Each of the schemes or duties may leave a characteristic pattern of faunal remains.

In husbandry for meat production, excess young males in a herd or flock might be slaughtered at their optimum size, with only a limited number being left to breed. Females would be kept to breed, and slaughtered only when they attained old age and ceased to be productive. Therefore, a bone assemblage characterized by a high frequency of young male animals and older females may signify a husbandry scheme geared toward meat production.

A husbandry scheme centered around milk exploitation produces a similar type of pattern. Here, adult females producing milk comprise the principal group. They are killed in old age when their milk supply dwindles. Male animals would be slaughtered at early ages, perhaps up to one to two years of age, depending on the relative importance of meat to the diet and economy of the culture.

Husbandry schemes oriented around wool and hair may leave a pattern in the bone remains where adult female and castrated adult males predominate. The fleece is normally taken from sheep and goats which are between two and six years of age (Ryder 1983). After this it becomes progressively more coarse, and less woolly. Flocks are sheared, probably according to some seasonal schedule, and depending on such factors as size, availability of resources, and economic, social and political criteria, may be herded great distances on transhumant journeys.

Slaughtering may follow a seasonal schedule. In many husbandry schemes, culling occurs in the autumn. At this time, unwanted stock can be removed from the herd or flock before the lean winter months, when fodder and proper accommodation are scarce.

Butchery

The basic processes involved in the slaughter, dressing, and butchery of an animal are generally uniform behaviours which do not vary significantly among cultural groups. These behaviours fall within relatively narrow and predictable ranges since they are all directed towards the fulfillment of a relatively fixed and limited tactical objective: converting a living entity into a consumable commodity. However, while the basic process of butchery usually shows little variation among cultural groups, a number of components such as the tools used, the level of organization exhibited, and the degree of efficiency and skill-level displayed can vary.

The study of butchery consists of two principal fields. First, zooarchaeologists can analyze the patterning in bone remains, noting the distribution and frequency of various bones which are associated with different cuts and qualities of meat. Second, zooarchaeologists can examine the chop, saw and cut marks on the bones themselves to reconstruct the procedures and technology associated with slaughter and butchery.

The frequency and distribution of skeletal parts can provide information about animal butchery. Animals are slaughtered, then butchered, with the resulting materials consumed or otherwise disposed of. It is important to note that each of these stages need not occur in the same place, and that the bone waste from each can be discarded in different areas. The result is a different patterning of skeletal parts, itself reflective of a part of the slaughter-butchery-consumption-disposal process. For example, a deposit of waste products such as the lower feet and cranial elements may be the result of preliminary butchery of animals, and might be used to distinguish the slaughtering and processing area for the animal carcass. Conversely, a deposit predominantly composed of bones associated with better-quality cuts of meat, such as the ribs, vertebrae, pelvis, and scapula, might indicate an advanced stage in carcass butchery close to or perhaps at the table-consumption level.

Slaughter and butchery of animals can leave distinctive marks on animal bones. These marks will vary in location, depth of cut, and orientation depending on the procedures involved. The analysis of these marks enables the researcher to determine the tools used and in many cases the pattern of slaughter and butchery for a particular taxon. "Chop" marks, caused by a chopper or cleaver, are noticeably deep and v-grooved. "Cut" marks are shallow, since they are formed by knives. "Saw" lines owe their clean and mildly jagged sliced appearance to the saw blade which formed them. Cleavers and choppers assist in disarticulating. They are best employed at the joints; therefore, there is a need to consider the anatomy of the animal when chopping it into cuts of meat. Hitting in the wrong area may be futile, in that the bone will not separate, or may cause excessive splintering, thereby ruining the meat with slivers of bone. With a saw, however, one can more readily ignore anatomical principles and simply saw through the bones cleanly and with little effort. Knives are generally reserved for filetting meat from the bone after the joints have been separated.

The choice of tools and patterning in their use as revealed on the animal bone gives information about the butchery procedures. Generally, smaller-sized operations, such as abattoirs with fewer than four people working, are characterized by low mechanization, low mobility of carcasses and high translatability (Peck 1986: 43). Butchers here may have to be trained in all aspects of slaughtering and butchery for a variety of animals. The space in which they perform these duties is normally quadrangular in shape and there is little compartmentalization of tasks. Larger-sized operations, on the other hand, often incorporate automated procedures and are arranged in a line system. Workers tend to perform specific duties along this continuum, which makes the procedure efficient but also quite rigid (Peck 1986: 43).

The skill-level of the butcher may also reveal itself osteologically. Highly skilled butchers normally make fewer mistakes than their unskilled equivalents and therefore tend to leave fewer marks on the bones. They also tend to be more efficient, causing less variability in the location and frequency of cut and chop marks owing to their superior level of anatomical knowledge. While large-sized slaughter and butchery operations often correlate with quite regular butchery mark patterning on the animal bones, such a pattern can also be made by a highly skilled butcher working at a much smaller establishment with several others, or even by himself. Therefore, skill-level may be independent of abattoir size.

Dietary Reconstructions

Most of the bone remains recovered from archaeological sites dating to the Roman period in Italy derive from animals which had been consumed. As such, the frequency of the various taxa represented can give an idea of the contribution of each to the Roman diet. Furthermore, the proportions of different cuts of meat, as shown by the relative percentage of bones associated with these cuts, afford the researcher more specific information about the contribution of meat within each taxon.

Perhaps the first distinction to be made amongst these taxa is the ratio of domestic to wild animals. Most of the meat consumed by the Romans derived from domestic animals. The rich, however, could afford to supplement their victuals with meat from wild animals. Dietary diversity indicated wealth, so people wishing to display their status conspicuously often chose to do so by consuming a wide range of domestic and wild animals. In addition, the value of a food resource was often enhanced if it had to be brought from some distance. Thus, a faunal collection containing a greater diversity of wild and domestic animals from a wider geographical area might indicate dietary wealth. Comparison of mortality curves of wild species from a site with what is expected of naturally occurring populations of those species will give one clues to the effects of human predation on them.

Wealth and status may also be indicated by the relative proportions of meat represented from within an individual taxon. When a majority of bones is associated with primary cuts of meat (i.e., tender and meatier sections such as those near the ribs and upper limbs), the people who deposited them were probably of elite status. On the other hand, a deposit dominated by bones associated with poorer cuts of meat might suggest consumers of a lower status.

Other Animal Products

Animals may also be used for products other than their meat, after their death. First, bones may be smashed to obtain the marrow inside. This is more likely to occur with long bones of larger animals, which have a greater supply of marrow. The process may show itself as an excessive amount of fragmented long bones in the faunal record. Alternatively, these bones may be boiled to extract the grease and oils concentrated within the marrow cavity. Unless otherwise protected, boiled bone generally disintegrates much more readily than fresh bone, and thus may not survive to be incorporated into the archaeological record. Its absence, therefore, may indicate the presence of extensive boiling practices in the past.

Second, bone, antler, and horn may be used as raw materials for the manufacture of tools or other objects, or commodities (e.g., glue). During Roman times the metapodial bones of such animals as cattle, horses and deer were often used for manufacturing pins, needles, dice, furniture inlay and other objects (Greep 1983; Hutchinson and Reese 1988). These bones would be sawn to obtain the fairly thick and flat midshaft area of the bone, leaving the sawn ends as waste. Some of this manufacturing was almost certainly conducted on a small scale, on the basis of fairly crude objects and little waste. However, a professional class of craftsmen might be deduced where the goods are of higher quality and more numerous, and where there is an accumulation of waste from bone workshops. Here, waste materials may include a number of offcuts, precursors, broken pieces, flakes and shavings, and trial pieces.

Finally, people may have exploited the hide or skin of the animal. During the process, the foot bones are often left in the skin until the fur or hide is worked. A furrier or tanner, therefore, may be expected to discard as waste the bones in the feet of the skins being used. These bones may show signs of knife cuts associated with their removal.

The recovery of numerous worked bone and antler pieces among a variety of Roman period sites in Italy verifies the existence of bone-working industries. Unfortunately, there is little evidence to determine the scale of this activity in many cases (Greep 1983). The characteristic bone waste associated with craft manufacturing, or hide, fur, or skin preparation, is often mixed amongst waste which derives from slaughter, butchery, cooking, and final consumption.

Ritual and Sacrifice

Animals are important in the ritual and sacrificial practices of many societies. Roman religion involved numerous animal sacrifices and, in popular practice, examples of superstitious usage of animal products. Unfortunately, it is not always easy to recognize such applications of animals in the archaeological record, let alone to decipher their significance. Often it is difficult, if not impossible, to distinguish this sort of variability from that created by differential functional usage of bones or differential preservation and recovery.

In many cultures, animal sacrifice is often suggested when an articulated skeleton of an animal species which is otherwise consumed is recovered. If an animal can be shown to have died of unnatural causes (i.e., perhaps at a young age and in the absence of life-threatening pathological illness), then it is possible it was deliberately killed and buried as part of some sacrifice or ritual. Human skeletal remains and religious or votive objects in association may add further clues to the ritual significance of the animal's killing. As such, the context of the burial determines its nature.

In some cultures, including Roman Italy, animal sacrifices generally form part of a religious festival. Although the procedures and meanings behind these events differ, the fact that normally these animals were eaten after the ceremony severely complicates reconstruction on the basis of faunal materials. Unless there are other indicators, therefore, a sample of bones from a sacrificed animal may not be distinguishable from a deposit of any other consumed animal.[13]

Many animals have a ritual connection to some deity or festival, and there are a number of examples from Roman times. For instance, the goddess Hecate had dogs as her consorts, while puppy sacrifices appeased her ruthless nature and ensured safe passage for deceased infants into the underworld. Roman farmers sacrificed many animals, but particularly lambs, on various occasions to protect their crops from disease, and to ensure and even celebrate a successful harvest. In some cases, therefore, it may be possible to link certain deposits of animal bones to a ritual involved with a particular deity.

* * *

Although animal bones can potentially contribute to reconstructions of the natural and cultural world, they have not always been analyzed with both of these intentions in mind. Bones from prehistoric contexts, before the appearance of humans, can only provide information about the natural world of that time, since the cultural realm did not exist then. In fact, with the exception of hominid and early human hunting, butchery and dietary analyses, much of the study of faunal assemblages which date prior to the period of animal domestication has concentrated on environmental reconstruction. The domestication of animals brought a change to this standard. Environmental reconstruction assumed a subsidiary role to the analysis of cultural patterns, at least in the Mediterranean area, particularly Italy. The climate of Italy has not changed considerably over the last 4,500 years (when compared to earlier glacial periods), and scholars argue that the climate during Roman times in Italy was very similar to present-day conditions there (Lamb 1977; Croke 1990; Greene 1986). Consequently, there has been a reduced need to use the faunal remains from archaeological sites to assist in general climatic and environmental reconstruction of Roman Italy. Moreover, since domestic animals predominated at most sites, less climatic and environmental information could be inferred from their analysis, simply because these domesticates can adapt to a wide range of conditions.[14]

While the advent of animal domestication has minimized the use of zooarchaeological remains for environmental reconstruction, it ushered in a host of cultural applications.

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[13] See note 8 above.

[14] Although the general climate of Italy may not have changed significantly since antiquity this is not to say that local and regional environmental conditions have remained similarly stable. The Romans directly and indirectly had an influence on and certainly modified local and regional environments in Italy through activities and factors such as agriculture, deforestation, pollution, mining, and industry. While environmental change may affect husbandry schemes, zooarchaeological data from domestic animals are inferior to geomorphological and palynological evidence in helping to reconstruct local and regional environmental change because, as noted above, domesticates can adapt to a broader range of conditions, and are protected and managed by humans (i.e., their demographics are not strictly influenced by natural conditions). The frequency of wild animals may assist in determining environmental change, especially deforestation, but this is complicated by the fact that even wild animals were not always free from cultural management in Roman times when one considers the construction of *vivaria* (i.e., wild game preserves), *leporaria* (i.e., similar preserves but generally for hares), or the raising of dormice in specialized containers (*gliraria*). See Chapter 7, in this thesis, for more about wild animals in Roman Italy. Further discussion of climate change, deforestation, and other environmental issues in antiquity can be found in Bell and Boardman (1992), Brückner (1986, 1990), Croke (1990), Hughes (1975, 1976, 1983, 1993, 1994), Hughes and Thirgood (1982), Meiggs (1982), Neumann, (1985), Thirgood (1981), and Vita-Finzi (1969).

Animals and their products were linked to many aspects of the cultural world. Domestication brought intensified and diverse animal husbandry schemes, themselves related to changing dietary, economic, social, and political patterns. Butchery was modified as a result of technological and economic change. Animals were harnessed for work and exploited for a number of renewable (e.g., milk, wool) and non-renewable (e.g., meat, hide, bones) products, but at the same time some were considered pets or given special treatment. Others assumed roles in ritual or ceremonial practices. Domestication, therefore, affected many aspects of the cultural world.

Since the main focus of this thesis is production and consumption of mammalian goods in Roman Italy, I shall deal primarily with the economic and dietary roles assumed by domestic mammals in this region of the Roman world. Although there are occasions where I might connect the analysis of these mammals with predictions about the ancient environment, I shall not attempt to reconstruct the ancient environment on the basis of the animal bones recovered.

Animal Production and Consumption and the Nature of the Archaeological Sample

As in all archaeological research, the sample of materials analyzed is often a portion of that excavated which itself represents only a portion of the original animal or cultural assemblage. Human groups herd, breed, hunt, and slaughter some species of animals, but other species die naturally. In both cases, the bones can be integrated into the archaeological record. Animal bones become frequent additions to this collection of archaeological remains by nature of their durability; however, this original assemblage in its pristine form is almost never what is studied. Rather, it is distorted by taphonomic processes, chosen by excavation selection, and retrieved in various capacities by sampling before it is analyzed. As one moves from original animal assemblage to death assemblage to archaeological assemblage to excavated assemblage and ultimately analyzed bone assemblage, information is lost. Each stage[15] in this process is dependent on the previous one for its source materials. Often only a sample of one stage is passed to the next. With so much loss and distortion of data and information along this path, it becomes difficult to determine how representative the retrieved and studied faunal sample is of the animal assemblage from which it is derived. Each stage must be accounted for in order to reconstruct the overall process so that accurate interpretations of the significance of the sample of bones can be presented.

Although data and information are lost at each stage, they are not necessarily irretrievably gone. One can reconstruct assemblages at each stage to some degree if the cultural and natural processes operating on them are known. In this way lost material can be accounted for and allowances made for its absence. This is a fairly easy process when attempting to understand the changes that occur from archaeological assemblage to excavated and analyzed assemblage. One needs to consider taphonomic processes and the manner in which the bones were excavated and recorded. However, the ultimate goal of reconstructing the original animal assemblage is hindered by many cultural variables which have acted primarily between the original animal assemblage and archaeological assemblage. Any study of the role of domestic animals in a culture cannot separate itself from the many cultural factors (i.e., economic, social, political, dietary, technological, and so forth) which are linked to animal domestication and which consequently impinge on all aspects of animal production and consumption. While the above specifically relates to domestic animals (i.e., mammals and birds) which usually predominate at most Roman sites, a similar argument can be made for any consumed animal. The choices involved in the acquisition, preparation, cooking, and eating of that animal are all influenced by cultural factors. These are not always easily interpreted because they often involve many complicated social, economic, and ideological factors. Animal production and consumption, therefore, are complex topics, which, I believe, require some manner of theoretical organization in order to analyze effectively. While in theory it may be true that the better the culture is understood in terms of behavioural regularities, the easier it may be to reconstruct its lifeways based on the recovered materials, in practice this becomes a formidable task. Models which outline general characteristics of human behaviour may provide a method of overcoming these hurdles.

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[15] Davis (1987), Gilbert and Singer (1982), King (1985, 1994), Meadow (1980), and Rackham (1983) discuss and model these stages. Basically, the continuum begins with the live animal, follows through its slaughter, butchery, and disposal, after which the bones are acted upon by taphonomic agents, with select portions recovered, analyzed, and finally published by the archaeologist. Various natural and cultural factors and agents operate at each stage.

Chapter 3

MODELING PRODUCTION AND CONSUMPTION

Introduction

While much information about animals in the Roman economy and diet can be gained through a combined analysis of zooarchaeological and textual data on the subject, I believe these results become more meaningful, or at least less particularistic, when interpreted within a modeled context for animal production and consumption. In this chapter I outline the value of models in the analysis and interpretation of archaeological data and propose one—the producer-consumer model—with which to investigate the role of animals in the economy and diet of Roman Italy. This model assists in identifying the economic nature of a site on the basis of its faunal remains by establishing characteristic animal bone patterns indicative of various levels of production and consumption.

Archaeological Models

Archaeological research is full of observations on accumulating data, all of which would be meaningless unless they are somehow simplified and ordered. According to Gibbon (1984: 132-133) "a model orders observations and minimizes perceptual confusion by organizing perceptions within a conceptual framework constructed by means of a rationale, or theoretical orientation." Thus, it would appear that models are essential in archaeological interpretation and analysis. They show that archaeology is not just historical but experimental.

A number of economic models exist in archaeology which examine the multiple facets and levels of production and consumption. These include opinions, concepts, and methods focusing on optimization schemes, ecological relationships (e.g., Higgs 1972; Bogucki 1989; Mithen 1990), food-webs (Jones 1992), world systems (i.e., core-periphery model, e.g., Wallerstein 1974), modes of production (e.g., Peacock 1982), labour and services (i.e., Marxist approaches), and site-catchment analysis (Vita-Finzi and Higgs 1970), to name just a few. Coded on top of these economic schemes are theories about decision-making, with some scholars arguing that human cognition is determined by external factors, such as the environment (Barker 1981; Gall and Saxe 1977; Jones 1992; Kottak 1972; Welinder 1975, 1979, 1983; among others), while others assert that people can, at least to some extent, make free decisions, independent of environmental, biological, or psychological effects (Hodges 1982; Renfrew 1984; among others). However, a number of scholars adopt positions between these two extremes, arguing for the importance of both ecological factors and human free-will in explaining cultural change (Giddens 1984; Zubrow 1975).

Given the vast array of models seeking to explain past economies, it would seem that there would be no problem in finding a suitable one for an examination of the Roman economy of Italy. Several do investigate the "economy" on a broad scale, but focus on production and consumption of goods such as ceramics and their contents (Greene 1986). Even where agricultural produce figures in the analysis, the meat and animal component of this equation is generally given a subordinate role to the discussion of grain and other topics such as farm-size, specialization, and labour relations (e.g., Garnsey, Hopkins, and Whittaker 1983; Morely 1996). Despite their evident value, the development and utilization of models applicable to zooarchaeological research of Roman period sites in Italy is rare. This contrasts with the strong theoretical direction taken by many researchers analyzing Roman faunal materials from sites outside of Italy, most notably in Britain (King 1978, 1984; Maltby 1979, 1984; Peck 1989; Webb 1989; among many others), and the efforts to understand, in nomothetic terms, prehistoric and medieval animal economies within Italy (Baker and Clark 1993; Barker 1985; Clark 1985, 1989, 1992b). Several excellent studies, based primarily on survey data, provide valuable information about changing patterns of animal husbandry throughout the Roman period, but these are often restricted to individual archaeological sites or small geographic regions of Italy.[16] Although there is a need for a detailed and extensive analysis of the animal economy of Roman Italy, the topic continues to receive only minimal theoretical attention. Perhaps scholars feel other issues dominate and require immediate clarification. Perhaps there are too many known and unknown problems hindering research. Whatever the reason, any model seeking to explain the animal economy of Roman Italy must be appropriate to the Roman economy as a whole, which is generally argued as somewhat complex (i.e., involving various scales and mechanisms of exchange, redistribution, and trade of animals and animal products). However, at the same time, the principles which generate the model cannot be particularistic, or only applicable to the Roman economy. In this case then, we run into problems of circularity, where the data are used both to generate and test the model. To avoid such problems, the economic model must be general in scope, but still testable using archaeological and textual data themselves specific to a certain time period, location, and culture, such as Roman Italy. One model, which has only recently been formulated by Gillian Clark (1987), achieves this goal, and can be applied to zooarchaeological research on Roman period sites in Italy. It will provide a theoretical basis from which to test hypotheses about the diet and economy of Roman Italy.

Economic Complexity: Producer-Consumer Model

Clark (1987) proposed a framework to interpret inter- and intra-site movement of subsistence items on the basis of the faunal materials recovered. I have chosen to use her model for two principal reasons. First, it is applicable to complex societies such as the Romans. The few other models which examine patterning in animal bone assemblages principally apply either to hunter-gatherer societies (Gifford-Gonzalez 1991; Shipman 1983), or to early farming economies and the coincident origins of animal domestication (Clutton-Brock 1978; Davis 1982; Meadow 1984).

Secondly, and perhaps more importantly, Clark's model fulfills a vital dictate of models in being both general and specific. The generality is in its use of universal principles of supply and demand, principles which could conceivably apply to any commodity, foodstuff or otherwise, which moves from a source of manufacture or production to a consumption destination. The occupants at one site make, those at another take; one gives, the other receives. Stripped to its core, the producer-consumer model essentially states that what is absent at the typical production site will be present at the typical consumption site, so long as the two are linked in some producer-consumer relationship. At the same time, however, Clark's model is specific enough that it can be easily implemented in archaeological research. The issue of movement of animal resources as reflected in the bones left behind and recovered archaeologically considers a fairly particular aspect of the ancient society—their animal bone waste. Specific, well-defined, and observable patterns as shown in the animal bone waste, therefore, inform us about general principles of animal production and consumption. Since the model combines general and specific concepts, it avoids the problems associated with a heavy reliance on one or the other; for example, theorizing about production without having defined the specific archaeological pattern by which the concept will show itself and be tested. D. Clarke points out that "we must generalize in order that we may particularize more powerfully" (Clarke 1972: 55), but at the same time the research problems we seek to answer should be well-defined and specific enough to be solved. I believe that the producer-consumer model achieves a balance between these two perspectives.

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[16] There is an increasingly growing body of literature on archaeological survey of Roman Italy. Some of the more recent references include: Arthur (1991), Barker (1995a&b), Barker and Lloyd (1991), Malone and Stoddart (1994), and Yntema (1993).

The first step is to identify producers and consumers. O'Connor (1992) suggests the terms "net consumer" and "net producer" be employed since there are many cases where consumers keep some animals (a production activity) and producers eat and use some of the resources from their own animals (a consumption activity). Whatever the terminology, common-sense generally dictates that urban sites are mostly consumers of agricultural and animal goods, which are generally chiefly produced at rural sites. While this may often be the case, Clark's model allows us to test these connections since there are certain patterns in the faunal remains which may assist in identifying a site as either a producer or consumer. Primarily, these patterns concentrate on the range of anatomical elements present and their relative frequency, and upon the ages, sexes and species of animals. It will be assumed that both producers and consumers attempted to maximize gains and minimize losses and therefore chose to promote the most efficient methods of achieving these goals.

Production Sites

The faunal remains recovered from production sites should display:

(1) evidence that a surplus of animals was raised. "Surplus" is defined as an amount in excess to the normal dietary requirements of the inhabitants at the site. For example, if one pig provided enough meat to feed the estimated, or calculated, number of occupants at a production site for one year, but over the same period of time the remains of 50 pigs were recovered, then a surplus of 49 pigs is recorded.

(2) an excess of butchery elements (if animals were moved as carcasses rather than on the hoof) particularly of younger male animals which were often the tastiest and the most expendable. Alternatively, very few bones may be recovered (if animals were moved on the hoof to an outside center). In this situation one might expect a marked discrepancy between the size and nature of the production center and the faunal sample; for example, there may be architectural evidence for many stalls or feeding troughs but no animal bones recovered.

(3) a non-realistic (i.e., non-natural) herd structure. "Non-realistic" or "non-natural" herds develop from human intervention in the natural distribution of ages and normal balance of sexes within a species. Most often this would be evidenced by many older breeding females but few mature males. Since a single mature male can fertilize many females, it is not economically sound to keep a great number of them solely for breeding purposes. However, a non-realistic herd structure may take a different form. For example, if animals were moved on the hoof to outside centers then naturally those sexes and ages chosen would be underrepresented or absent from the site.

(4) evidence of young animals in the dental data but not in the fusion data (if animals were moved as partially prepared carcasses which excluded the heads). In this case, the typical waste products such as the heads and feet would likely be discarded at the production site, whereas cuts of meat from the rest of the animal's body, including the majority of skeletal elements which mature through fusion of epiphyses, would be exported.

Additional indicators may include:

(5) archaeological evidence for the existence of meat preservation, either salting, drying, or smoking, if this occurred prior to export.

(6) literary or textual references alluding to the productive nature of the site or area.

Consumption Sites

On the other hand, faunal remains at a consumer site should show:

(1) a predominance of animals of prime meat ages, usually younger individuals. In a highly organized and controlled system one might expect a great regularity in ages, wherein only animals of a specific age were slaughtered. Since young animals often provided the tenderest meat, they would naturally be preferred.

(2) a non-realistic herd structure with evidence for very few breeding females and many younger males. Such a herd would not be ideally suited for species propagation, again showing human intervention and control.

(3) a lack of bone debris associated with butchery waste products (if animals were not moved on the hoof). If animals were exported from production sites as partially prepared carcasses, then the butchered remains from parts of the animals, especially the meatier areas, would be recovered from consumption sites. On the other hand, animals moved on the hoof to consumption sites would need to be slaughtered and butchered there, subsequently producing much bone debris.

(4) evidence of young animals in the fusion data but not in the dental data (if the heads and other waste parts were discarded during butchery at the production site).

(5) anomalies between the animals present and the environment of the site. The recovery of bones of animals which could not have lived within the ecological limits of the site indicates importation of goods. Animals may have been imported alive or dead, as whole or partial carcasses, and need not have been exclusively or originally brought to the site for dietary consumption.

Additional information may be extrapolated from:

(6) literary or textual references alluding to the consumptive nature of the site or area.

Finally, there are two factors for which faunal materials provide information but which cannot easily be categorized as definitely production or consumption criteria. Inferences can sometimes be made from faunal remains about:

(1) social differentiation causing different classes of food. Wealthy individuals are more likely to purchase or receive the choicest cuts of meat. They can also afford to diversify their diet with expensive exotic meats and specialty foods.

(2) collection and distribution points such as markets, warehouses, butcher shops, smoke- and salthouses and similar types of facilities or structures. Aside from clues derived from artifacts, structures, and written inscriptions and documents, these might be recognized in terms of faunal remains by a concentration of particular bone elements normally from animals of prime meat-bearing ages.

The relevance of these two points depends on the context of the site. We might expect to find a greater level of social differentiation in an urban consumption site where food materials are purchased and distributed. Those with access to better cuts of meat, and with the necessary currency (or bartering materials) for its procurement, could have obtained them, leaving second-rate cuts for the poorer classes. Rural villas, on the other hand, may show less of a social contrast in cuts of meat since their owners often had first access to the resources. However, social differentiation may be displayed among the faunal remains of the villa had the slaves deposited their refuse in a separate spot from that of the elite villa owner.

Although markets, butchery shops, and warehouses are commonly found in urban areas and thus may assist in clarifying their productive and consumptive nature, they are not exclusive to these sites. A rural villa may have acted as a local market for its hinterland, and in doing so immersed itself into the consumption economy. But, it still played a role in producing these goods, by acquiring or raising the animals as part of its livelihood.

Before the economic complexity model can be implemented and tested in this thesis some important preliminary points must be addressed. There is always the danger in model building of tautology, or in other words using the same data to derive and ultimately support an interpretation (Clarke 1972: 41). If this is the case then the result is not a "model" but rather an interpretation of the possibly cultural-specific patterns which have been observed. These problems of circularity and specificity are difficult to overcome. In constructing a model the researcher should first seek to determine underlying common behaviours in a culture, and subsequently build the model around these. To simplify the process he or she must assume that there is no great range of behaviours in humans over a certain time period. Thus, in the case of the economic complexity model outlined here, the underlying common behaviours can be summarized as supply and demand. The components of the model then relate these common behaviours to specific patterns in the animal bone waste which help distinguish who is supplying goods and who is demanding, or consuming those goods. With only minor modifications, the model could be applied to a great variety of cultures and societies across the globe and throughout time, and is not, therefore, specific solely to Roman Italy.

The problem of circularity in argument has been controlled in this present analysis by the fact that none of the sites in Roman Italy have been previously classified as "production" or "consumption" sites on the basis of their faunal remains; therefore, it is impossible to conduct my research with preconceived ideas about site labeling derived from the analysis of animal bones recovered at each. In other words, the data cannot be used both to obtain and support an interpretation. The characteristics of production and consumption had been outlined before the data were analyzed.

Clark (1987: 185) stresses two further points regarding her model in particular.

> Firstly, the sample from each site **must** [her emphasis] be considered in relation to the contemporary environment of the site, locational factors, and the social/cultural context. Secondly, attention also must be paid to matters such as recovery levels, taphonomic processes, symbolism, and disposal and preservation practices.

It is necessary to determine the natural and cultural context surrounding the faunal sample in order to understand its relationship to the producers and consumers who created it and the taphonomic agents which may have modified it. We are predisposed to view ancient cultures as economically rational in that they strive to maximize gains and minimize losses. Generally this holds true, but cases can arise which refute these "rational" standards. Circumstances may develop in which consumers demand a certain resource which does not coincide with an agriculturally rational productive scheme. For example, a consumer-driven high price for the meat of young female animals may prompt a producer to sell much of his supply. Yet, in so doing he has performed a somewhat irrational move by limiting his future brood stock. It simply becomes a matter a choice (Huelsbeck 1991). Economic factors are usually important. In many production sites the occupants prefer certain animal resources for consumption, and export others as part of an economic or trade system. Depending on external or internal demands and choices, they may choose to utilize local or distant environments and resources. Social factors are omnipresent. Animals, particularly domestic livestock, are, and were, a "cultural attribute" (O'Connor 1992: 103). Their possession and control served a social function far beyond the simple provision of meat, milk, wool, or hides. Political factors can also have an influence. Episodes of war and new governmental policies can dramatically change systems of supply and demand. Ideological factors too may play a role. Irrational behaviours sometimes are deeply rooted in religious or traditional practices. Thus, preferences, choices, and ultimate decisions are never dissociated from social, economic, political, and ideological factors—in short, the cultural context.

Placing a faunal sample within its proper and unique cultural context is essential for each site. Therefore, every site must first be assessed at an individual level before inter-site comparisons can be presented. I have attempted this to the best of my ability for all the sites used in this thesis. However, there are complications. The amount of information about each site varies to a considerable degree—several volumes in length for some sites, brief reports for others. A compromise must be reached. Since it is impossible to comprehend fully, and integrate perfectly all aspects of each site—and one cannot hope to obtain every bit of missing information—I limit my attention to details about each site which impinge directly on the faunal materials and their context of recovery. Mention may be made of other archaeological features, architecture, and artifacts but generally only where they provide a clearer picture of the setting or context for the animal bones.

Considering all the biases and limitations of using zooarchaeological and textual data, coupled with conflicting opinions on how exactly to characterize the ancient economy, it is obvious that a complete and universally applicable framework, or model, of the role of animals in Roman Italy cannot be constructed. However, while full details may elude us, some fundamental principles are accessible. The fact that most of the ancient writers were so practical and efficient in their treatment of this topic allows for the formulation of basic points about animal production and consumption which we could expect to see reflected in a distinct pattern in the archaeological record and in turn in the animal bone remains. I believe the best way to organize this research is to split the presentation of information into two broad headings: production and consumption. "Consumption" concerns the role of meat and other animal products in the Roman diet, while "production" encompasses everything related to the creation and development of these resources. Both production and consumption encompass a variety of subtopics. Production chiefly incorporates the issue of animal husbandry. Consumption might be separated into topics such as the acquisition of food resources (including trade and transport of animals and animal resources, as well as their subsequent marketing, sale, and distribution[17]), the contribution these foodstuffs make to the diet, and methods and reasons involved in preparing and eating consumables, in addition to those for disposing of waste.

To simplify the presentation and integration of the zooarchaeological and textual data, I have chosen to analyze these various components of production and consumption in separate chapters. In each chapter I present first the zooarchaeological data on that subject, then the information from the ancient references, and follow with a section where the two sources are integrated and compared. Animal husbandry is a large topic, especially when we consider the great amount of zooarchaeological and textual data for each species. I shall divide the discussion of animal husbandry into three chapters to correspond to the three principal domestic mammalian taxa consumed in Roman Italy: cattle, sheep/goat, and pig.

Once the individual subtopics of production and consumption have been dealt with, and the textual and zooarchaeological material on each presented and integrated, I can test the modeled criteria for production and consumption sites with the zooarchaeological and textual data.

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[17] As noted earlier, because is little zooarchaeological evidence available to aid in the analysis of trade, transport, marketing, sale, and distribution of animals and animal products, these topics will not be considered in this thesis since they lie outside its scope which is to compare zooarchaeological and textual data. On the possible shipping of meat to/from Roman Italy as suggested by animal bones recovered from Roman shipwrecks in the Mediterranean see Farello (1990a) and Parker (1992a&b). On the existence and function of markets, fairs, and shops in the distribution of commodities (although not necessarily animals and animal products) see de Ligt (1991&b), Frayn (1993), Hermansen (1974, 1981), Kleberg (1957), MacMullen (1970), de Ruyt (1983), Shaw (1981), Sirks (1991), and Whittaker (1997).

Chapter 4

MATERIALS AND METHODS

> The most important stage now [for zooarchaeology] is overall synthesis, and comparing the results with data from other sites. (Davis 1987: 46)

In this chapter I introduce the zooarchaeological data from Roman period sites in Italy. I categorize each site according to geographic location, time period and site type, and state a few assumptions for the subsequent analysis of their zooarchaeological data. I assess these data in light of recovery and preservation conditions at each site, and quantify the contribution of various animal taxa as recorded on the basis of their zooarchaeological remains.

Introduction

Despite the recognized value of zooarchaeological research for cultural reconstruction, there have been relatively few studies of faunal materials from Roman periods sites in Italy compared to Roman sites in the northern provinces (e.g., King 1978, 1984; Luff 1982; Thomas 1989).[18] Of the vast number, perhaps thousands, of Roman period sites known and excavated in Italy, I have found fewer than one hundred from which animal bones have been recovered and analyzed. Although together these sites span the entire Italian peninsula and incorporate all time periods of classical antiquity, as yet no one has attempted to combine their results to develop a general synthesis of the role of animals in the economy and society of Roman Italy. Several local syntheses exist. Riedel (1986) tabulated and interpreted faunal data collected from Neolithic to Medieval sites primarily in Northeastern Italy. King (1985, 1993) compared several sites in two reports. First, he incorporated data from various Roman periods sites in Central Italy in an attempt to place the faunal findings from the Roman villa at Settefinestre in Etruria into a broader context (King 1985). Second, he compared the zooarchaeological patterns shown at a number of sites in the Naples/Pompeii area (King 1993). Albarella (1993) performed a similar comparative study using the bone remains from San Giacomo in Molise alongside a few other sites, while Barker and Clark's (1995) report on the faunal data collected during the survey and excavation project in the Biferno region of Molise synthesized information from Neolithic to Medieval times for this area. Although these studies are influential in propagating our knowledge of animal economies in Italy, their specific geographic and/or temporal focus renders them of only limited use to our understanding of the role of animals over all of Roman Italy. A general survey and analysis of all Roman sites in Italy which have faunal remains is necessary to provide a larger context for the research of Riedel (1986), King (1985, 1993), Albarella (1993), and Barker and Clark (1995), and to discover patterns and links which may cross-cut geographic and temporal divides.

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[18] Zooarchaeological reports on Romano-British sites predominate amongst these. Thomas (1989) listed 280 sites with faunal evidence, a figure which has grown considerably in the last decade. Germany ranks second with numerous reports, many coming from the Munich school under Böessneck and his students.

Of the 73 Roman period sites in Italy which comprise the zooarchaeological database for this study, only four (i.e., San Giovanni, Gravina, Lugnano, and Ossaia-Cortona) represent material which I have analyzed personally. The remainder was accumulated from the published and unpublished reports of other zooarchaeologists. The faunal analysts associated with each site are listed in the 'reference' column of Tables 3 - 10. Those who have also conducted zooarchaeological research at four or more Roman period sites in Italy sites include U. Albarella, G. Barker, S. Bökönyi, T. King, J. De Grossi Mazzorin, and A. Riedel.

Compiling these data was a challenging task. There is no gazetteer or inventory of archaeological sites in Roman Italy which reports faunal findings. Rather, information is scattered amongst numerous, and often very obscure, journals, monographs, and unpublished research reports. In addition, published material appears in a variety of languages including Italian, English, French, and German. German reports concentrate on northern Italian sites, while the English and French reports deal principally with dispersed sites in central, and less commonly southern, Italy.

Once the data were collected, I endeavored to organize them. The first step was to identify the type of site each best represented amongst four categories: rural site (=rural), large urban site, or "city" (=urban1), smaller urban site or "village/settlement" (=urban2), and special site (=special). The allocation of sites to these categories was based on information provided in the original excavation reports as well as general perceptions about site size and productive/consumptive capacity interpreted in light of archaeological and historical classification schemes for urban and rural centres. Rural sites were often labeled as such by the principal investigators, while many urban sites were situated in a present-day town or city, which was also known to be urbanized during antiquity. Although there is never a clear dividing line, the common impression was that rural sites would provide some information about animal production, since this is where farm animals would be raised, while urban sites would yield data primarily on consumption of animal goods, since there would be more people to feed in a city or town, with less space to raise and herd animals.[19] Production, however, must always be viewed through the filter of consumption, since most bone waste is linked directly to the consumption of meat, or the access to some other product such as the hide, tendons, bone, and so forth, which can only be retrieved by killing the animal.

It was fairly easy to distinguish rural sites. Nearly all had been classified by the excavators as Roman rural, or at least suburban, villas, even though they varied in size and may not be located technically in the countryside on the basis of present-day geography. In some cases, the bone remains from these sites derive in whole or in part from middens. At other times, they represent waste scattered over the area which had been dated to various periods of occupation or abandonment at the site.

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[19] Thomas (1989) adopted a similar approach and rationale for his analysis of cattle in Roman Britain. He distinguished between those sites assumed to have produced (e.g., rural villas) and those largely reliant on food provisions (e.g., military and urban sites). Military sites are not included in my thesis, since none where animal bones were recovered and analyzed are currently available for Roman Italy.

The classification of urban sites was more difficult than rural sites. Urban sites vary in terms of size, population, history, form, and function. Determining all of these parameters for urban sites of the past on the basis of limited archaeological and textual data is anincredibly complex, and in most cases impossible venture. Broad estimates of size and population are often all that can be calculated. Divisions like "city," "town," and "settlement" might be used to group sites, generally on the basis of population figures or estimates. However, it must be remembered that each of these categories often brings with it different expectations concerning urban life, which are not universally applicable.

Since few size or population estimates were available for the urban sites used here, I chose to label sites as either urban1 or urban2 on the basis of the Roman definition of cities and villages/settlements. The word "city" is usually applied to a planned urban settlement with its own municipal administration. However, some unplanned villages could also acquire this status. From the Republic onwards, the title *municipium* (pl. *municipia*), came to distinguish such urban centres in Italy with administrative duties. Thus, any archaeological site known to be within one of these ancient *municipia* was labeled as urban1. Most *municipia* contained elements of urban life such as streets, a *forum*, water supply and drainage systems (e.g., wells, fountains, cisterns, aqueducts, sewers), shops, houses, public buildings (e.g., basilicas, *curiae*, temples, *macella*, baths), monuments, and entertainment facilities (e.g., amphitheater, *odea*, circus, *stadia*). Many were fortified.

It is important to realize that *municipia* size varied considerably in antiquity. Sites such as Pistoriae (modern Pistoia) and Cosa, for example, although still labeled as *municipia* in antiquity, were probably small in comparison to cities such as Neapolis (modern Naples), Aquileia, Altinum (modern Altino), and perhaps Mutina (modern Modena) and were certainly tiny in relation to Rome. Moreover, *municipia* size, importance, and existence fluctuated over time. Pompeii, for example, was destroyed in AD 79. Luna (modern Luni) seems to have shrunk into a small and inconsiderable city by Strabo's time (5.22), while Mutina prospered at least until the late 4th century AD (Amm. Marc. 31.3).

Two sites—Kaulonia and Spina—not expressly known as Roman *municipia* were labeled "urban1." Both were considered important pre-Roman cities, but neither seems to have continued as such during Roman times. Founded in the 7th century BC, Kalounia was a fairly large late Iron Age city in southern Italy, complete with temples, houses and city walls.[20] It was destroyed in 389 BC. Although rebuilt in the 4th century BC it was abandoned by the 1st century BC. Spina, on the northern Adriatic coast, flourished as an Etruscan/Greek city, but declined with the invasion of the Gauls in the north (Dion. Hal. 1.18.5) and was reduced to a mere village during Roman times (Strab. 5.1.7). Considering that the faunal materials from Kaulonia and Spina derived from pre-Roman contexts in both cases,[21] I decided to label each as urban1, since both sites were effectively "cities" at this time.

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[20] Locri, founded in the 7th century BC, is another important city in southern Italy. Although it became a municipia, Roman Locri was considerably smaller, and presumably less important than its late Iron Age and Hellenistic counterpart. Regardless, the faunal deposit from Locri used in this thesis derives from a sacred well, or bothroi, and thus has been grouped in the "special" category.

[21] But still within my temporal groupings (i.e., post 500 BC). Refer to the subsequent discussion of temporal and regional divisions used in this thesis.

Sites not specifically marked as *municipia* in antiquity, but with some urban character, were labeled as urban2. Excavation at some of these uncovered a number of structures indicative of a small community or village, more than an isolated villa but certainly less than a city. While they are certainly not *municipia*, the exact status of these urban2 sites is not always apparent. Some may have been vici, or towns/villages (e.g., Udine). Others, especially those along transport routes, may have been settlements established for the purposes of supplying or funneling goods, or have acted as way-stations for travelers (e.g., Stufels, Invillino-Ibligo). Still others may have been small suburban settlements located near, but not specifically part of, larger *municipia* (e.g., Torcello is near Altinum; the sites in the Metaponto territory are situated outside the city proper).

The final category was special sites. Any unique context—such as a burial site, a votive deposit, disposal of some animal in a well, and sof forth—was labeled as "special." Although some of these sites were located in urban or rural settings, and could on the basis of geographic setting be labeled as "rural" or "urban," I chose to distinguish them as "special" to avoid biasing general economic and dietary interpretations about "rural" or "urban" sites. Periodically, the animal bones from "special" sites may provide some information about the ancient diet and economy, but this must always be filtered through the nature of its context. A dead dog may be thrown down an abandoned well for quick disposal, but a collection of lamb bones associated with a human burial need not imply a predominance of pastoralism in the economy, or a preference, or distaste for that matter, for lamb in the diet.

Having assigned a site-type label to each site, the second organizational step was to group them into several basic temporal and regional clusters. Italy has always been a collection of regions, which I believe first require individual contextual analysis before being placed into the larger geographic picture. Currently, peninsular Italy is divided into 18 regions, which more-or-less conform to the ancient Roman boundaries.[22] Some of these regions, however, may be grouped according to shared landscape features and/or environments, and further defined by the degree that they are set apart from other areas by natural boundaries such as river systems or mountains . I recognize three such broad geographic regions: (i) Northern Italy, (ii) Central Italy, and (iii) Southern Italy. These are depicted in Figure 1, along with the location of each site.

For the purposes of this thesis, Northern Italy consists of the present-day regions of Val D'Aosta, Piedmonte, Liguria, Lombardia, Veneto, Trentino-Alto Adige, Friuli-Venezia Giulia, and Emilia-Romagna.[23] It is characteristically a zone of wealth, often allying itself with northwestern Europe more than with the Mediterranean world. The climate is continental rather than Mediterranean, enjoying plentiful rain and comfortable temperatures. The dominant river drainage system is that of the Po River, which, with its tributaries, channels through the Italian Alps to the north to create a richly fertile plain, ideal for many forms of agriculture. These plains, as well as the mountain slopes, are home to much wildlife and numerous natural resources, such as timber and minerals. Several mountain passes such as the Mont. Cenis, Little and Great St. Bernard, Brenner, and St. Gotthard provide relatively easy passage to Europe and effectively link northern Italy to continental Europe. The Apennine mountains to the south provide a uniform barrier blocking off this wealthy region of northern Italy from the rest of the country.

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[22] Although there are eighteen regions presently in peninsular Italy there were only eleven during Augustan times. The boundaries for the regions of Central and Southern Italy have remained fairly similar through the ages, while the large, encompassing area of Northern Italy, known as Cisalpine Gaul in antiquity has since been divided into a number of smaller regions such as Val D'Aosta, Piemonte, Liguria, Lombardia, Veneto, Trentino-Alto Adige, Friuli-Venezia Giulia, and Emilia-Romagna.

[23] This corresponds, roughly, to Regions VIII, IX, X, and XI as demarcated during Augustan times.

Central Italy encompasses the present-day regions of Toscana, Umbria, Marche, Lazio, Abruzzi, Molise and Campania.[24] Geographically, this area is bounded by the Apennine mountains which stretch across the northern limit, south of the Po River, continue down through the central section, especially near the Adriatic side of Italy, and widen again in the south across the region of Campania, effectively separating central from southern Italy. The interior section of Central Italy, bounded by these two expanses of the Apennines, consists of a series of fertile river valleys and mountain plateaus. The bulk of the population in central Italy lives mainly on the western side of the Apennines in several key regions including the plains, hills, and Tyrhennian coastline of Tuscany and Latium, the city of Rome, and the Bay of Naples area in Campania. Smaller pockets of settlement occur in the steeper valley areas along the Adriatic coast. Central Italy generally experiences a Mediterranean type of climate characterized by warm, wet winters and hot, dry summers. Although not as wealthy as Northern Italy, the area is fairly sound economically.

Southern Italy is roughly demarcated by the modern-day regions of Apulia, Basilicata, and Calabria.[25] Currently it is probably the poorest region, economically, compared to central and northern Italy, but it does contain several cities such as Bari, Taranto, and Lameria where extensive industrial activity and development presently takes place. Natural resources are few, with some exceptions, such as oil and gas at Ferrendine. Much of the area today is given over to agriculture, but pastoralism was important during the past. Population densities are low. The mountainous terrain of Calabria limits habitation, while the chance to earn more income elsewhere forces many to migrate from the south to other parts of Italy. Although generally Mediterranean in nature, the southern Italian climate can be quite extreme and often unpredictable. All this adds to the poverty and economic insecurity which is today generally characteristic of this region, but not necessarily equally visible throughout.

Italian history has also been divided into a number of chronological phases often marked by shifts in political power or cultural affiliation. Thus, we speak of an Iron Age, an Etruscan period, a Hellenistic period, Republican and Imperial times, and late Antiquity, to name a few of these phases. These chronological phases, moreover, are often associated with various cultural categories—such as archaic, classical, and hellenistic—themselves based on stylistic changes in Greek art. The greatest problem in using any of these set chronological phases, be they artistically or culturally derived, is that many of them cannot be extrapolated over the whole of Italy. Some might be unique to a specific region of Italy

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[24] Roughly equivalent to Regions I, IV, V, VI, and VII from Augustan times

[25] This corresponds, roughly, to Regions II and III from Augustan times.

(e.g., Etruscan period dominated in Etruria; the hellenistic period of art prevails in southern Italy) or vary chronologically from region to region (e.g., the Roman conquest of Italy was a gradual process, and most peoples were not fully incorporated into the Roman Republic until the 80s BC, even though the Republican period elsewhere in Italy and especially around Rome may have officially begun centuries earlier). Moreover, these two classification schemes—one based on artistic changes, the other on socio-political events—do not always conform in terms of dates, which further compounds the problem of correlation. Since a complete chronological harmony amongst all regions of Italy is a difficult, if not impossible task, I have chosen to use three broad time brackets—(i) c. 500 BC - c. 50 BC, (ii) c. 50 BC - c. AD 300, and (iii) c. AD 300 - c. AD 500—rather than rely, too heavily, on established socio-political, cultural, or artistic phases. For the sake of simplicity, I shall refer, respectively, to these time phases as (i) Republican times, (ii) Imperial period, and (iii) Late Antiquity (or Late Antique times), even though the dates and durations may vary depending on which region of Italy is being considered. Imperial and Late Antique times have fairly uniform dates throughout Italy. By the Imperial period the whole of Italy was incorporated into the Roman empire. However, not all people in Italy were subjugated into the Roman Republic by 500 BC; regions gradually become conquered up until the first century BC, at which time the whole of Italy was under Roman rule.

The first time period noted, c. 500 BC - c. 50 BC, coincides primarily with Republican times. Republican Italy began in 508 BC with the expulsion of the last of the seven kings of Rome. However, as noted earlier, southern and northern Italy were not incorporated into the Roman Republic until later. This period was characterized by frequent wars as Rome carved out its empire over Italy and the Mediterranean, encountering and subjugating, but also borrowing and learning from, various indigenous tribes and cultures along the way. It was also a time when Italy is said to have become "Romanized," an often ambiguously defined concept. The culmination of Republican Rome in terms of animals and agriculture occurred in the 2nd and 1st centuries BC coincident with various land reform schemes, conquests of new regions, and proliferation of Latin literature, including farm manuals.

The second time period chiefly encompasses Imperial times. The Imperial period officially commenced in 27 BC when Augustus became emperor. Wealth and prosperity were at their climax at this time as yet more new lands and their resources fell into Roman hands. This extravagance is displayed in Latin literature in terms of increased reference to gastronomic delights, and elitist activities such as game-hunting.

Unlike Republican and Imperial Rome, Late Antiquity has more of a flexible starting date, depending on which event one chooses to highlight. The whole period is usually characterized as one of general decay, as Rome struggled to maintain its empire in the wake of barbarian attacks and economic and political crises. However, research shows that not all areas suffered; indeed, some regions of the empire, including parts of Italy prospered during Late Antiquity. For the purposes of this thesis, I designate the year AD 286, when the emperor Diocletian split the Roman empire into Eastern and Western divisions, as the onset of Late Antiquity.

The division of Roman Italy into three geographical zones and three time periods yields nine groups for the organizing of zooarchaeological remains:
Southern Italy: (i) Republican, (ii) Imperial, (iii) Late Antiquity
Central Italy: (iv) Republican, (v) Imperial, (vi) Late Antiquity
Northern Italy: (vii) Republican, (viii) Imperial, (ix) Late Antiquity

The Sites

Southern Italy

The general pattern amongst archaeological sites of southern Italy (at least those with animal bones) is that Republican and Iron Age sites predominate, with only a few sites dating to Imperial times and Late Antiquity. The last five centuries BC in southern Italy were typically dominated by archaic, classical, and hellenistic settlement. As such, the area maintained links with Greece. Even after Roman occupation, southern Italian culture still remained Hellenized. Republican and Iron Age period sites lie primarily along the coast, while survey and archaeological work inland provides some examples of Imperial and Late Antique settlement in central Apulia and Basilicata (e.g., Roberto and Small 1994; Small 1991).

(i) Republican (Table 3)
Thirteen sites from this region yielded faunal remains which date to Republican times. I have not included any sites from Sicily in this analysis. Some of these sites recorded below show long periods of occupation from the 7th, 6th, and 5th centuries BC until the end of Republican era, making it sometimes difficult to separate Iron Age, Hellenistic, and Roman phases. None appears to originate during Roman times.

(ii) Imperial, and (iii) Late Antiquity (Table 4)
There are limited faunal data available which might help to reconstruct economic and dietary changes in southern Italy during the transition from Republican to Imperial times. The settlements at Gravina and Metaponto do not extend for any length of time into the Imperial Age, and those sites with lower archaeological levels dating to the 1st, 2nd, and 3rd centuries AD produced only very small samples of animal bones (NISP of 61 for phases I and II at Otranto, a Roman and Medieval settlement area on the southern Adriatic coast in Puglia; NISP of 178 for Period 1 at the Roman villa of San Giovanni, inland Basilicata). The partially excavated rural villa of San Biago, in the territory of Metaponto, appears to be the only exclusively Imperial-aged site from southern Italy for which animal bones have been recovered; however, like other contemporary deposits in the area it too produced a relatively small sample of bones (238 NISP).

Central Italy

The majority of sites from which animal bone remains have been recovered and analyzed are located in central Italy. This area has received much archaeological attention over the years, most likely due to the current and historic concentration of settlement, particularly around present-day Rome and Naples.

(iv) **Republican** (Table 5)

Twelve sites, or parts thereof incorporate faunal remains dating to the Republican period in central Italy. Combined they span from the 6th century BC until the early 1st century AD, and include bone waste derived from both urban and rural settlements as well as that recovered from ritual and burial contexts. Not surprisingly, all of these sites are situated on the western side of Italy—Etruria, Latium, and Campania—a region historically associated with much political, social, economic, and settlement activity coincident with the formation and growth of the Roman empire.

(v) **Imperial** (Table 6)

Imperial age sites from central Italy dominate the list of sites with animal bone remains—twenty-three exist, which include a fairly equal sampling of rural and urban sites, supplemented with several ritual-type deposits. Although these sites are more widely distributed over the whole geographic area of central Italy than their Republican comparatives, the bulk is still located in Etruria, Latium, and Campania. Several sites (notably, Settefinestre, Ossaia-Cortona, Pompeii, and Ostia), bridge between Republican and Imperial times, and thus assist in documenting economic and dietary modifications (if any) at this juncture. Settefinestre is particularly important in noting temporal change since occupation there continues beyond Republican and Imperial times into Late Antiquity as well.

(vi) **Late Antiquity** (Table 7)

Central Italy contains eighteen sites with animal bones from Late Antique contexts. Most of the rural villas mentioned below were destroyed or abandoned during or shortly after this period, while their urban counterparts (especially in the Naples area) often show continuous signs of occupation through Medieval and modern times. Again, as typical of most settlement in this area, the majority of these Late Antique sites are found in Etruria, Latium, and Campania. Molise, however, receives special attention, mainly through the efforts of the Biferno survey project (Barker 1995b).

Northern Italy

Northern Italy seems to show a reverse trend in settlement to that recorded for southern Italy. A few Republican sites scatter the northern Italian landscape; many more date to Imperial times and Late Antiquity. With only a couple of exceptions, these sites cluster in north-eastern Italy, not surprisingly the geographic area of interest for prominent Italian zooarchaeologist, Alfredo Riedel.

(vii) **Republican** (Table 8)

The chronology of Republican sites in northern Italy is complicated. Although the more recent levels at Spina and Colognola do fall within the general Republican time frame (c. 5th BC - 1st BC), most of northern Italy (Cisalpine Gaul as it was known in antiquity) did not become part of the Roman empire until the 2nd century BC. Thus, with the exception of Pozzuolo del Friuli, which was likely established after Roman conquest of north-eastern Italy, our evidence of Republican settlement in northern Italy must be filtered through sites which contain late Etruscan and late Iron Age levels.

(viii) Imperial (Table 9)
Nine sites located in northern Italy contain Imperial age deposits with animal bones. Almost all of these are "settlement" types of sites, in that it is difficult to determine the extent of their urban or rural nature based on the excavations. The majority likely represent small collections of buildings more characteristic of a *vicus*, rather than a large rural villa. Many of the inland sites presumably represent small stations set up along the mountain passageways to develop or exploit local resources and assist in channeling trade through the northern Alps. Those on the coast may have served in funneling sea-borne trade.

(ix) Late Antiquity (Table 10)
Eight sites with animal bones from late antique levels are located in northern Italy. Some settlements established during Imperial times, namely Invillino-Ibligo and Volano, continue into Late Antiquity. Several rural villas were also formed during Late Antique times in Northern Italy, particularly in the interior regions of the upper Po valley.

The Data

Any comparative analysis involving various sources of data requires compromise, especially when there is great variation in the amount and quality of those data, not to mention the procedures used to generate and analyze them. Compromise in zooarchaeological research has three components. First, as already discussed in Chapter 2, we must understand the nature of the archaeological sample and effectively compensate for what is known, what can be reconstructed or inferred, and what is lost. Second, assumptions must be made to organize the data, and bring them to manageable proportions. Finally, we must strive to standardize the data to reduce bias.

Assumptions

I make two broad assumptions in this thesis. First, I assume that the faunal remains from any of the "special" sites are relatively unique and may help illuminate some aspects of the economy and diet, but these must always be interpreted in the context of the original "special" nature of the site. Secondly, I assume that the faunal materials recovered from at least the "rural" and "urban" Roman period sites in Italy designated above somehow reflect aspects of the economy and diet of the area, unless there are strong indications to the contrary, such as the overwhelming presence of foreign species, or the lack of all expected domestic species. A predominance of bones associated with cuts of meat and/or waste products principally of domestic species characteristic of the geographic area, the accumulation of faunal remains within midden deposits at a site, and the presence of butchery marks on the bones which can be associated with the slaughter, butchery, and consumption of animals might all be criteria used to indicate economic and dietary patterns. The fact that this information is first specific to a site and its immediate area, however, leads to a further consideration. The Roman economy and diet is extremely regional in nature. A pattern produced in one area should not be extrapolated over the whole country. Yet, the fact that the criteria demarcating production and consumption in animal resources may be present or absent to various degrees depending on the site, or the fact that any researcher must always be aware of the regional nature of the Roman economy, does not negate any form of comparison amongst the sites. Some data may be directly comparable in many respects while others only in some respects. Some data may illuminate the picture for a certain region of Italy which in turn might be compared to the picture generated in a different region. The results may be clear in some areas and hazy in others. Although I cannot seek to answer all the questions about the role of animals in the Roman diet and economy of Italy, I can nevertheless contribute what I consider a valuable synthesis of information for this ultimate goal.

Data Standardization

Comparisons of zooarchaeological data become more meaningful when these data are standardized. The ideal condition, therefore, would necessitate similar recovery techniques at each site, uniform taphonomic biases, and a standardized analytical procedure. While zooarchaeologists can strive to reduce some of this variation by implementing a fixed routine of recovery and analysis, the specific nature of the taphonomic, or burial, environment of each site will continually inhibit complete standardization of data. In addition, depending on the site, there may be a number of other biasing factors to consider, such as the influence of the cultural context, or chronological and regional variation. Some of these biases may surface and be compensated for readily; others might require extensive research before they can be understood, or in some cases even recognized. Until data sets can be fully standardized in zooarchaeology, therefore, any comparative analysis hoping to achieve highly specific results must address every bias affecting every sample. This is an immense, if not impossible task, and one which I cannot achieve in this present analysis of zooarchaeological samples from Roman period sites in Italy. While some of the reports I am using contain detailed information about the biases affecting the zooarchaeological samples recovered, many do not discuss, or even address these concerns. There are simply far too many unknowns, and, short of re-enacting each excavation, no way of retrieving all of this information.

Although the nature of the data I am using in this analysis inhibits me from formulating highly specific conclusions, it does not prevent me from recognizing and interpreting patterns and deriving general conclusions. The data can still effectively be compared if we consider them as interpretative material rather than as rigid factual results. Moreover, the closer I can get in standardizing the data by addressing some of the more common biases, the greater the measure of control in this analysis. In the following section I address two major concerns which influence the sample of bones unearthed and analyzed from a site—recovery of bone remains, and preservation and taphonomy—as each relates to my analysis of zooarchaeological data from Roman period sites in Italy.

Recovery of Bone Remains

Information about the use of screens, bone preservation conditions, and the incidence of carnivore gnawing for the sites is presented in Table 11. Sites which span several time periods, such as Settefinestre, have not been subdivided into temporal phases for this analysis, unless specific mention was made of differential recovery for materials from different phases or contexts (e.g., as at San Giovanni—parts of middens sieved, others parts not; Lugnano—cemetery deposits sieved, others not). Screening has been scored as "most" (generally over 50% of excavated soil sieved), "some" (roughly 5% to 50% of soil), "little" (below 5%), and "none." Preservation conditions are scored as "good," "fairly good," "fair," and "poor." The incidence of carnivore gnawing ranks as "some," "little," "limited," and "none." Sites are arranged according to geographic region, time period and site type, beginning with southern Italy, Republican period, rural sites and progressing to northern Italian urban sites of Late Antique date. Those sites without information about screening, preservation, and carnivore gnawing are excluded from the table.

Considering that the method of recovery is integral to the composition and subsequent interpretation of the faunal sample, it is unfortunate that very little detail is presented about bone recovery from Roman period sites in Italy. It seems that the bulk of the faunal material from all but several sites was retrieved via manual recovery in the trench. Moreover, since very few, if any, small bones figure amongst those samples with no reported recovery information, I would predict that most of the sites with "na" recordings (as well as all those not listed) did not use screens in bone retrieval. Approximately 25% of the faunal reports mentioned using screens, and less than 5% used wet-sieves. Of those excavations that did employ screens or sieves, generally only selected samples were subjected to these intensive procedures, this usually being those samples with the greatest potential to yield many and/or special bone pieces (e.g., the cemetery at Lugnano, the middens at San Giovanni di Ruoti, the pit at Gravina, the well at Naniglio). Although it is often necessary to limit the area which can be sieved, considering the expense and time involved, such selectivity can introduce biases which must be compensated for if materials and sites are to be compared. It cannot be assumed that these "bone rich" samples are typical. Researchers, therefore, should clearly explain which recovery scheme was used and in which area. In addition, they should state the mesh size of the screen or screens used. Finer meshes will catch most bones of tiny rodents, small birds, and fish, which have a greater chance of falling through larger meshes. Although mesh sizes were not always reported for the sites above, the typical mesh size for dry sieving with which I am familiar falls within the range of 8-10 mm, while the smaller sized mesh is usually 4-5 mm. Meshes of 2 mm and 0.5 mm are normally reserved for wet-sieving procedures.

Screens no doubt allow the recovery of a more complete sample, by picking up many of the smaller bones. Their use, however, does not necessarily change the overall relative frequency of the medium and large-sized mammals. Those animals that are easily recovered in the trench by visual inspection are the medium and large-sized individuals (Barker 1975), which include the three principal taxa contributing to the Roman economy and diet: sheep/goats, pigs, and cattle. In some cases, therefore, the relationships and data trends amongst these taxa may be compared effectively, even when screens were not used. Steele (1983) found that the relative frequency of these three taxa did not change significantly when screens were employed at the site of San Giovanni. He concluded that vigilant trench recovery was just as effective as screens in providing generalized results about these principal taxa. Other zooarchaeologists concur with Steele, mentioning the care with which animal bones were recovered in the trenches at their excavations. In the majority of cases, every effort was made to collect animal bones, and many of these remains are large enough to be visible while excavating. While I cannot control for bone material not collected, I assume that, unless otherwise destroyed, most of the remains from the three prominent taxa—pig, sheep/goat, and cattle—were recovered during the excavation of the various sites used in my analysis here. In this way, I can control, to some degree, recovery biases. However, appropriate caution is required when it comes to comparing samples of bones from smaller animals such as rodents amongst the sites. Trench recovery will likely miss these taxa; therefore, in this case one should only compare results from sites which have used screens.

Preservation and Taphonomy

The preservation condition of a bone relates to a number of taphonomic variables, such as the nature of the burial (i.e., rapid or slow, cumulative burial), soil conditions, the degree of chemical and physical weathering, rodent and carnivore activity, among others. A quick burial in slightly basic or pH neutral soils free of carnivore and rodent activity preserves bones well, whereas disposal on the surface where the bones are subject to the elements, or burial in acidic soils, or marked carnivore and rodent gnawing will all act to destroy them. Zooarchaeologists are increasingly aware of these biases and now seek to discuss them in their reports. A review of Table 11 shows that practically all of the reports with any taphonomic information date to the late 1980s and 1990s, a period during which much taphonomic study was conducted. Twenty-four reports state that bones were in "good" to "fairly good" condition. The nature of the sample in these cases generally conforms with this. At Lugnano, bones were buried quickly in the cemetery (MacKinnon 1998). A similar argument applies at Hipponion-Vibo Valentia. The rapid accumulation of bones in middens at sites such as Carminiello, San Giovanni, Matrice, Monte Barro, and likely Via Gabina, Modena, and Spina, promoted good preservation, as did deposition in fairly protected places such as wells and cisterns (e.g., Naniglio, Vaste, San Giacomo), pools (e.g., Monte Gelato), pits (e.g., Gravina), muddy conditions (e.g., Cosa), or anaerobic environments (e.g., Classe). The Pompeii 94 sample is in good condition since it is chiefly composed of bones from animals which perished during the volcanic eruption of AD 79. It includes several horse and dog skeletons.

Fourteen sites had bones in "fair" condition, while five list samples in "poor" condition. When combined, these "fair" and "poor" sites fall into three general categories. First are those sites located in or very near Latium and Tuscany (i.e., Settefinestre, Ossaia, Lugnano, Ostia). Acidic soils predominate in these areas, and no doubt contributed to the relatively poor preservation of general bone collections from these sites. The second category consists of sites in the Naples and Pompeii region (i.e., Via San Paolo, Girolamini, S. Patrizia, Pompeii 95). Volcanic soils coupled with the increased potential for disturbance from the great degree of settlement activity in this area likely helped destroy and/or fragment much of the bone remains from these sites. The Pompeii 95 material is older than the Pompeii 94 material, as well as from a different context (scattered garbage as opposed to whole skeletons). As such, it was subject to different and presumably harsher taphonomic factors. The last broad category of sites with bones in "fair" to "poor" condition covers those from southern Italy (i.e., Cozzo Presepe, Gravina, Locri, Roccagloriosa). The dry, hot climate of this region likely heightens weathering and other post-depositional destructive forces, while the characteristic hard-packed clay soils probably exacerbate fragmentation by leaching minerals and increasing bone fragility.

Several of the reports used in this analysis noted how fragmented the sample of bones was, using qualifiers such as "highly," "extremely," or "very fragmented." Assessing bone fragmentation is a difficult and somewhat subjective process. On the one hand, measures or estimates of the degree of fragmentation in a faunal sample are related to recovery techniques. A sieve will collect the small bone fragments which may otherwise be missed in hand-collected samples. If there are many of these unidentified tiny bone pieces in relation to the NISP component then the sample may give the impression of being "highly fragmented." A review of Table 11 indicates that this is the case for a number of sites—San Giovanni, Narce, Pompeii 95, Campochiaro, Monte Barro—where a correlation between "some" or "most" deposits screened and observations of "very fragmented," "highly fragmented," etc. faunal samples exists. However, there are also cases (e.g., San Giovenale, Forum Transitorium, Pozzuolo del Friuli, Palazzo Dugentesco, Invillino) where "fragmentary" samples were reported but screens were not used in recovery.

While recovery techniques will affect how fragmented a sample appears, cultural and natural taphonomic agents certainly contribute to the actual fragmenting of this material. The degree of fragmentation often correlates inversely with the state of preservation, although not always. Samples with "highly fragmented" or "quite fragmentary" remains generally also rate "poor" preservation conditions. In most of these cases, taphonomic factors have acted to fragment the sample; however, there are examples—such as at Narce, San Giovanni, and Monte Barro—where good preservation conditions abound but the samples are still considerably fragmented.[26] It is necessary to distinguish the causes of bone fragmentation to determine how much of it occurred post-deposition, so that we do not confuse this with fragmentation caused from butchery and other pre-depositional cultural processes. Moreover, we must factor in the impact that screening has in contributing to the number of fragmentary bone pieces.

While rating preservation conditions and the degree of fragmentation of a zooarchaeological sample provides some information about site taphonomy, there are complications when it comes to site comparisons. Generalized comments about preservation such as "good," "fair," and so forth are quite subjective, and often based upon the zooarchaeologist's recollection of the condition of various samples he/she has previously analyzed. There is no standardized scale or an accepted test which more objectively measures preservation states. Recording the pH of the soil is one step towards achieving this goal. However, more is required. Following King (1985, 1994) and Albarella and Davis (1994a), I propose a relatively simple test using the bone remains: calculate the percentage of teeth in the sample relative to all other skeletal elements. Teeth are generally the most durable faunal materials and, assuming whole animals were discarded and recovered, may indicate the degree of post-depositional destruction of the remaining skeleton. I calculated this statistic for those sites which provided a breakdown of skeletal elements. These are listed in Table 12, in order of decreasing #teeth/NISP statistics. The values are based upon figures provided for cattle, sheep/goats, and pigs exclusively, since many reports only supply a breakdown by element for these taxa. Although some reports include vertebrae and ribs amongst their tallies, many do not; therefore, to limit the bias of potentially reducing some of the ratios calculated in Table 12 by inflating NISP values, neither rib nor vertebrae counts have been included in the NISP figures listed in Table 12.

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[26] I suspect the high ratings for fragmentation in these three cases are related to the use of screens in recovery.

Figure 2 displays the ratios calculated in Table 12 grouping the sites according to geographic region and temporal group. Teeth comprise less than 40% of the total cattle, sheep/goat, and pig NISP figures at the vast majority of sites (86.8%) listed, suggesting relatively consistent preservation conditions amongst most sites. A few sites register very high values (i.e., San Giovanni, San Costanzo, Lugnano); however, this should not be taken as an indication of poor preservation conditions. Rather, these sites do not fulfill the original assumptions of the "preservation statistic" in that whole animals were not always interred here. The San Giovanni sample contains an excess of pig heads, thus skewing statistics. Similar circumstances apply to the Lugnano cemetery and San Costanzo burials. In addition, it is not surprising that those sites with high ratios also screened much of their deposits. Screens will collect many of the smaller sheep/goat and pig teeth which can be missed during trench recovery, especially if they have fallen out of the mandible or maxilla. Screens will also trap more non-dental bone fragments, but many of these cannot be identified to taxa and element to the degree that teeth can. As a result, values for the ratio of #teeth/NISP tend to become inflated.

Are there differences in preservation conditions on the basis of temporal period or site type? Grouping sites by temporal period (without including San Costanzo, San Giovanni-period 3, Lugnano-period 3, and Roccagloriosa, votive) and calculating the respective means yields values of 21.2 for Republican period sites (n=13), 22.0 for Imperial period sites (n=17), and 24.9 for sites of Late Antiquity (n=19). While there is no statistically signficant difference between these ($X^2=0.34$, df=2, $0.8<p<0.5$), the trend intially from observation of these mean values seems to be: the earlier the site, the better preserved the bone material. We might expect the reverse to be true considering some Republican period bones had been interred for centuries more than their later equivalents. Perhaps bones from Late Antique sites were subjected to harsher taphonomic forces, with more left on the surface (more sites abandoned?), as opposed to earlier time periods where bones may have been more readily buried (and protected) in order to clear or prepare areas for continuous occupation. This pattern is consistent over three-quarters of the sites listed where occupation spans two or all three of these temporal periods (e.g., Settefinestre, Lugnano, San Giovanni, Matrice, Via Gabina, Volano, Carminiello: Republic to Imperial), but does not occur at some sites (e.g., Monte Gelato, Luni, Carminiello: Imperial to Late Antiquity).

Grouping the sites by site type (i.e., rural, urban1, or urban2—not using Lugnano, San Giovanni, San Costanzo and Roccagloriosa) and calculating means produces values of 29.2 for rural sites (n=18), 18.0 for urban1 sites (n=16), and 20.8 for urban2 sites (n=8). Although the chi-square value ($X^2=3.03$, df=2, $0.3<p<0.2$) is not statistically significant at the 0.05 probability level, it does approach significance at the 0.20 level. These data support the statement of a notable difference between bone preservation at Roman urban and rural sites in Italy. Overall, bones from rural sites seem to have endured relatively poorer preservation conditions than did their urban counterparts. This prompts questions about general disposal practices between urban and rural site types. Rural occupants may be more apt to discard their animal bone waste in open middens or other similar places where it might be left exposed to a greater number, or more intense range of taphonomic agents. Urban occupants may be more inclined to bury their rubbish, or otherwise somehow directly or indirectly limit the taphonomic impact on it. However, this pattern might also be produced if relatively more animal heads, or at least their teeth, were retained at rural sites compared to urban sites. Alternatively, more post-cranial elements could be imported to urban centres (and presumably exported from rural sites). Both scenarios would act to inflate the #teeth/NISP values for rural sites in relation to urban sites.

If we tally up the number of bones and teeth in a typical cattle, sheep/goat, and pig skeleton, we get values of around 166, 166, and 229, respectively.[27] Teeth account for about 20% of these figures (i.e., cattle and sheep/goat normally should have 32 adult teeth, and pigs, 44 adult teeth). Therefore, if all bones and teeth were originally discarded, preserved, and later recovered at an archaeological site, we should expect teeth to comprise about 20% of the sample. Adjusting this to exclude ribs and vertebrae, which are not usually identified to species in NISP counts, gives a value of about 30% teeth. Using this figure as a guide, we might argue that any site where teeth account for a very low percentage of the sample—say perhaps less than 10%—is one where differential recovery has occurred (i.e., teeth were missed, deposits not sieved, etc.) or whole animals were not interred (i.e., whole or partial heads removed from site, or post-cranial parts added later). This pattern would be more likely in deposits which contain food/table waste, where we might expect more cuts of meat to be served. Considering the high durability of teeth compared to other skeletal elements, it is unlikely that taphonomic factors (i.e., preferential destruction of teeth over all other bones) could solely account for such low ratios in these cases.

Faunal assemblages with very high frequencies of teeth (e.g., greater than 50%), on the other hand, would be better candidates for arguments relating to differential preservation, with enhanced taphonomic destruction of non-dental elements, and/or explanations involving differential deposition, where post-cranial elements were removed and/or extra teeth brought in.

As with the analysis of preservation conditions, judging the degree of fragmentation in a bone sample has typically been a rather subjective process. Zooarchaeologists use terms such as "highly fragmented," "very fragmented," and so forth, without a standard scale as a foundation. I expect they have made these assessments on the basis of relative comparisons with other bone samples with which they are familiar. Thus, one may compare, fairly reliably, preservation and fragmentation ratings among bone samples collected using similar techniques and analyzed by the same zooarchaeologist, but should be wary when comparing those analyzed by different scholars and under different recovery regimes. A standard test of fragmentation is required. A few researchers (Albarella and Davis 1994a; MacKinnon, in press) have calculated the percentage of isolated teeth as a proportion of all teeth, and used this to indicate the degree of fragmentation. Teeth will more readily fall out of the mandible or maxilla if the bone is broken, crushed, or otherwise fragmented. Single-rooted teeth tend to slip out more easily than multiple-rooted teeth. King (1985, 1994) calculated the number of fragments per animal (#frags/MNI), the number of bones/animal, and the number of fragments per bone in an attempt to ascertain objectively levels of fragmentation. Another test might be to determine the percentage of unidentifiable long bone shaft fragments to identifiable long bone pieces or complete long bones. There has been a tendency amongst zooarchaeological writing to just report on the identifiable pieces. This ignores the unidentified component which is integral to our understanding and reporting of preservation and taphonomic conditions.

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[27] These values are averages for mature individuals (i.e., fused epiphyses) and count individual left and right mandibles, but do not include individual bones of the cranium. Thus, the cranium registers only as "one." Ribs and all vertebrae (including caudal vertebrae) are included in these counts. The number of bones and teeth in individual animals may vary depending on a variety of factors including presence of sesamoids, pathological conditions, developmental problems, and cultural practices (e.g., removing the tail).

Carnivore Gnawing

Considerable research exists on the topic of carnivore destruction of bones. Although other animals such as pigs and rodents may also gnaw on bones (Greenfield 1988), carnivores (i.e., dogs, wolves, hyenas, etc.) usually cause the most damage, and are far more ubiquitous. Damage can range from little to total destruction of elements and assemblages (Binford 1981; Brain 1976, 1981; Haynes 1980, 1981, 1982, 1983; Payne and Munson 1985; Stallibrass1990; among others). Carnivores (almost exclusively dogs in the case of Roman period sites in Italy) typically start at the ends of long bones, where the fragile cancellous bone is located, and follow with gnawing on the shaft. The presence of carnivore marks helps reconstruct key events in the post-depositional history of a faunal sample. First, they testify that carnivores had access to the materials; however, this does not always imply that these animals were given free access, or that these dogs were necessarily kept on the premises. Second, although dogs may uproot buried bones, the presence of carnivore marks generally indicates that the bones had been unburied for some period of time.

Table 11 lists the incidence of carnivore gnawing. Only seventeen sites, or parts thereof, recorded such information; most provided nothing. This absence of information, however, should not be taken as an sign that carnivores did not act on these remaining samples. Rather, it probably indicates a fairly insignificant level of carnivore gnawing, and in some cases total absence. Had carnivores done considerable damage to any of these samples, I would have expected some mention in the report, at least in those published following the important studies of the effects of carnivores on bone assemblages in the early 1980s (e.g., Binford 1981; Brain 1981; Haynes 1980; Payne and Munson 1985).

Overall, carnivores inflicted minimal damage on the bones from most of those sites listed. Approximately 65% of those sites with such information recorded "little" to no carnivore activity. Their contexts support this result. Evidence suggests that the faunal materials were buried quickly at the Lugnano cemetery and subsequently protected from most carnivores. A similar argument applies to the bones in the Gravina pit (and presumably Hipponion-Vibo Valentia, Cantone, and any animals which perished in the eruptions at Pompeii, although data are unavailable). "Minimal weathering" on the Via Gabina bones adds further support to the proposal of rapid burial here. Carnivores had limited, if any access to animal remains discarded in the protective environments of the Naniglio, Vaste, and San Giacomo wells/cisterns, as well as the Metaponto kiln, and the Cosa lagoon. I expect a similar situation applies to other well deposits which make no reference to carnivore activity (e.g., Capaccio, Gravetta) providing that this is the primary disposal context for the materials contained within.

Quantifying the amount of carnivore damage to a sample of bones is difficult. No consistently applied test exists. Some researchers (Assad 1986; MacKinnon, in press) calculated the frequency of gnaw marks on various skeletal elements and taxa. This provides some information; however, such figures potentially underestimate the real frequency of gnawed bones, considering that any bones completely destroyed or at least highly fragmented beyond recognition by carnivore activity would not register in these counts. Moreover, how would one recognize, let alone quantify bones crushed and comminuted by carnivores that did not display observable gnaw marks? The ratio of #teeth/NISP, calculated above in Table 12, may help. Teeth survive well amongst carnivore damaged samples because they are harder and relatively unpalatable to dogs (Payne and Munson 1985: 35), and so it is assumed that their higher incidence reflects increased or intensified carnivore activity. A comparison of #teeth/NISP values from Table 12 with the few available comments made on the incidence of carnivore gnawing in Table 11 offers some support. All but one of the sites (Monte Gelato-period 3) which reported any carnivore activity have values greater than the 23.3 mean.

There are insufficient direct data on the incidence of carnivore gnawing to draw conclusions about the differential treatment of bones from urban and rural sites; however, some general comments can be made. Available evidence suggests that, aside from specially protected deposits, the incidence of carnivore gnawing amongst rural sites is generally greater than that shown at urban sites. Rural sites figure prominently amongst those sites reporting any carnivore damage, while the vast majority of urban sites provide no such information, which, as mentioned above, may indirectly indicate minimal carnivore activity. The argument for significantly increased carnivore activity at Roman rural sites in Italy compared to urban sites is supported if the #teeth/NISP ratios calculated in Table 12 and displayed in Figure 2 do in fact measure, to some degree, this activity. The rural mean of 29.2 (n=18) is substantially larger than the urban1 and urban2 means (18.0 [n=16] and 20.8 [n=8], respectively), thereby supporting the notion of a greater incidence of carnivore activity at rural over urban sites. We might expect such a pattern, and for a couple of reasons. First, rural life generally requires a greater number of dogs for shepherding, hunting, and protection than would be needed normally in an urban setting of comparable size and population. More dogs implies more gnawing. Second, many rural dogs largely or exclusively feed by rummaging through middens, or by being tossed the occasional dinner scrap, while urban pet dogs generally have access to fewer bones other than those given to them by their owners or keepers.

Other Taphonomic Factors

Few reports mention anything about other taphonomic factors. A couple note the presence of rodent chewed bones (e.g., San Giovanni, Lugnano). However, the damage is quite minimal in all cases. The possibility of pigs ravaging the bone remains from the site of San Giovanni is considered, but these animals do not appear to be significant agents in bone destruction here compared to the damage done by carnivores (MacKinnon, in press). Although other faunal reports from Roman period sites in Italy do not specifically discuss the role of pigs as taphonomic agents, I suspect these animals would generally have limited access to bone waste which accumulated inside abandoned structures.

As regards other taphonomic agents, some reports provide information about the number of bones showing exposure (e.g., San Giovanni, Via Gabina, Lugnano). The degree and intensity of exposure is a good measure of the amount of time bone has been at the surface subjected to the elements. Above-ground weathering often produces longitudinal breaks in the bone and tends to erode the bone rapidly (Behrensmeyer 1978; Lyman 1994; among others). Some weathering occurs after burial, but it is slight when compared to bones exposed on the ground surface for extended periods of time. Fewer reports (e.g., San Giovanni) detail information about post-depositional etching on bones, or attempt to subdivide breakage patterns (i.e., spiral break, fresh break, break due to unknown cause). More note the incidence of burnt bone (e.g., San Giovanni, Lugnano, Via San Paolo, Girolamini, Via Gabina), but this is generally discussed in the context of cultural modifications to bones, specifically cooking and food preparation. Cultural modifications to bones (e.g., butchery, cooking, and bone working) will be discussed later in this thesis.

Sample Size

Table 13 lists the total number of bones collected and the total NISP for the sites. The sites are arranged in decreasing order from highest to lowest NISP totals. Those sites which span two or more of the three temporal divisions (i.e., Republican period, Imperial period and Late Antiquity) are subdivided into their component phases, as designated in the "Period" column. The total number of bones collected was not always reported, and has been estimated in some cases. Sometimes the NISP figures record solely the number of mammal bones identified. In other cases they record combinations of NISP figures for mammals plus some or all of the remaining classes of animals. Columns 7-11 list the NISP values for each class of animal. This information could not be obtained for some sites.

A review of Table13 shows that sample sizes and NISP values vary considerably. The NISP portion of this is depicted in Figure 3. Just over half of the total number of sites register NISP values of less than 500; a great number of these are less than 100. Approximately 44% of the sites record counts of over 1,000 identifiable pieces, but only a couple of these exceed 10,000. Clearly, caution must be exercised in comparing sites at these numeric extremes, although this depends heavily on the questions being asked. Gamble (1978) suggests that small samples can help to answer certain general questions about the economy and diet at a site. He argues that many levels of inquiry, such as ranking or relative percentages of domestic species, require only small samples. Davis (1987: 46) provides a very rough guide. Ten identified bones will tell us which species were exploited; 100 identified bones can tell us roughly in what proportion humans exploited them; 1,000 identified bones can provide us with some demographic information about the more prevalent species, while 10,000 identified bones allow us to reconstruct better the complete demography of that once living animal population, and to examine spatial and temporal changes in this at the site. While large sample sizes often do yield more information, there is still much that can be done with samples in the 100 to 1,000 size range, especially in terms of ranking a species' contribution to the diet and economy, and understanding various basic aspects about its exploitation. Nevertheless, there will be occasions throughout this analysis where I will be forced to exclude sites with smaller sample sizes, so as to reduce the effect they may have on skewing results and interpretations.

Figures 4 - 6 present the number of sites per NISP sample size category according to site type (Figure 4), region (Figure 5) and time period (Figure 6). Although it may be a bit unfair comparing site type, region, and time period with NISP sample sizes, considering the latter is heavily influenced by the amount excavated and the recovery techniques used, some incidental comments may be made. Urban sites predominate within the larger sample size categories, but they also account for the majority of sites with samples below 100 NISP (Figure 4). Rural sites comprise a great percentage of the number of sites within the 100 to 1,000 NISP range, but also occur in the 10,000+ category, as well as in the <100 category. All of the 15 special sites listed have NISP sample sizes of less than 5,000; nearly two-thirds of them are less than 500 NISP.

Despite their multitude, no sites from central Italy have NISP values greater than 5,000 (Figure 5). Rather, northern Italy records relatively more sites above 1,000 NISP than either southern or central Italy. The bulk of southern sites lies within the 100-1,000 NISP range, but one tallies in the 10,000+ group.[28]

According to Figure 6, Republican period sites generally account for relatively more of the smaller NISP sample sizes, especially within the 100-500 range. The pattern for Imperial period sites is less distinct. Their relative number compared to sites of other time periods generally decreases, albeit slightly, as one moves from the smaller sample sizes to the larger ones, although Imperial period sites account for the majority of those sites above 10000 NISP. The standard for sites of Late Antiquity seems to follow a reverse trend than those of the other two periods in displaying relatively more sites with larger NISP sample sizes. While there are fluctuations, the overall pattern exemplified in Figure 6 as one moves from low to high NISP sample sizes can be summarized as: Republican—decrease in relative number of sites; Imperial—slight decrease in relative number of sites; Late Antiquity—increase in relative number of sites. Considering that the results of the analysis using the #teeth/NISP statistic indicated that preservation conditions seemed to worsen as we moved from older to younger sites (see Table 12 and Figure 2), we might expect, therefore, a reverse trend for sample sizes than is shown (i.e., poorly preserved and subsequently smaller samples from Late Antique sites, better preserved and potentially larger samples from Republican period sites). Since preservation conditions do not accord with the sample size comparisons, other factors must explain this pattern. Any number of possibilities such as relatively more area excavated at Late Antique sites compared to earlier ones, or tendency to excavate more bone-rich deposits at Late Antique sites, to address only a couple, might explain why these sites contain relatively larger NISP sample sizes. There is probably no simple answer.

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[28] These patterns are certainly related to the excavation goals of the individual project, which may have a geographic component. For example, archaeological teams in northern Italy often undertake vast projects. The region has typically been influenced by German zooarchaeological research, especially that from the Münich school, under Böessneck. Animal bones are viewed as an important component to cultural reconstructions, and efforts are made to retrieve them. Emphasis is often placed on the analysis of animal size and its relation to breeding practices, thus large samples are ideal. Southern Italy has several large-scale British, Canadian and Italian projects (e.g., San Giovanni, Roccagloriosa, Gravina), where again efforts were made to retrieve animal bones. In central Italy, however, there are a number of smaller projects, at which animal bone recovery is not necessarily a goal of the researchers. As such, those faunal samples collected from this region may be predisposed to be smaller.

Identification

A list of the mammalian species and taxa identified is given in Table 14. The information presented is summarized according to site type. In light of the knowledge that modern-day collections and manuals can reliably assist in the identification of animal bones from Roman times, it does not appear that mis-identification is much of problem. I assume that the identifications made on the remains used in this analysis are accurate to the best of the researchers' ability.

By Roman times most of the animal species used by humans had been domesticated. Therefore, domestication does not factor heavily in my analysis. I assume that all of the farm animals identified are domesticated, unless otherwise indicated by the researcher. On the other hand, I assume that all the animals hunted are wild, unless identified as otherwise. Some wild animals may have been tamed and some domestic animals might have escaped and become feral, but these constitute rare exceptions and should not significantly skew comparisons ratios of **typical** wild to domestic individuals among sites.

The data from Table 14 indicate that the remains of domestic mammals have been identified from every Roman period site in Italy where animal bones were recovered. Sheep/goat and pigs occur at all rural and urban sites; cattle were identified at all urban sites and 93.3% of the rural sites. Clearly these three taxa dominate the Roman diet and economy regardless of the deposit. Equid remains register at over 80% of the rural and urban1 site types, but 60% and less at urban2 and special sites. Horses are by far the most common equid identified; in most cases the percentage of sites with horses is around three times that of the corresponding donkey and mule figures combined. Dogs bones were identified at over two-thirds of the sites, and were especially prevalent amongst rural sites. Cat bones, however, were infrequent finds amongst most site types, but were recovered at about 25% of the rural and urban1 sites.

Wild animals are represented at more than 75% of all rural and urban2 sites, but figure at less than 50% of urban1 and special sites. Deer, and in particular red deer, are the most common wild animal amongst all site types, usually followed by lagomorphs (especially hare) and wild boar. Rural sites contain the greatest variety of wild animal species, while special sites rate the least.

Rodent bones are not specific to any site type, but do occur in much greater frequency amongst rural sites. In general, rodent species are two to three times more prevalent at rural sites than at urban or special sites. Since the incidence of rodent bones depends heavily on the use of screens in recovery, it is not surprising that rural sites also retain the highest percentage of screened deposits (see recovery section above). Mice and rats are the most common rodent species regardless of site type.

One method of analyzing the taxonomic abundance of a sample is to compare the number of species (NS) to NISP. Higher NS/NISP ratios indicate a greater variety of species at that particular site, relative to the number of bones recovered, whereas lower ratios suggest less variation in the faunal sample, perhaps the result of a cultural concentration on fewer animal species. Table 15 lists the mean NS/NISP ratios according to geographic, temporal, and site type groupings, condensed from the individual recordings for each site which are given in Appendix 2. Only mammalian species and NISP counts are considered. Sites with NISP values less than 200 as well as those marked with an asterisk (i.e., total number of species not counted in these cases; estimated values used) have not been included in the calculations for Table 15. Rodent species of little economic importance (i.e., mice, rats, and voles) have not been included in either count. Dormice, however, are included in the calculations because they were commonly consumed.

Although the number of sites within each temporal/geographic/site type group is often very small (i.e., sample sizes generally from two to four sites) broad trends are still visible in the data from Table 15 and Appendix 2. The data fairly consistently indicate that rural sites, regardless of location or time period, have a higher number of different mammalian taxa compared to other types of sites, especially if we do not include samples below 200 NISP. This is consistent with the data presented in Table 14. Rural sites, in general, contain more taxa. Moreover, the data from Table 15 suggest that rural sites in central and southern Italy register a greater variety of mammalian taxa than their northern counterparts. The gradual increase in mean NS/NISP ratios from Republican times through to Late Antiquity for rural sites in central Italy suggests a concomitant rise in dietary diversity in this area. These people appear to have added more variety to their consumed animal resources over time, especially by incorporating a greater assortment of wild animals to their menu. A reverse pattern is shown for rural sites in southern Italy. Here, the data suggest that alimentary variety declined over time. NS/NISP ratios for urban sites tend to decrease over time, regardless of geographic area, suggesting a progressive decrease in dietary diversity. On the basis of these data, therefore, Late Antique urban settlers appear to have consumed a more limited range of mammalian species than their Imperial and Republican counterparts.

Quantification

Although there are a number of quantification methods used in zooarchaeology, I chose NISP and MNI for this analysis. NISP values were consistently recorded for each site, while MNI values were reported at more than half of them. Other quantification methods were infrequently applied. Ten reports—Locri, Gravina-pit, Pompeii-Ganimede, Colognola, Pozzuolo del Friuli, Pistoia, Stufels, Torcello, Innichen, Udine—tabulated bone weights. Most of these sites were located in northern Italy. A diagnostic zone[29] approach was applied at two sites—Cozzo Presepe and Gravina (Watson). Two other sites—San Giovanni and Lugnano—had used the meat and offal weight (MOW) method as proposed by Vigne (1991) in the estimation of relative amounts of consumable resources, while one report, Kaulonia, applied a similar, but not fully explained, type of meat estimation method.

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[29] The diagnostic zone method consists of recording pre-established zones on the bone material. For example, a humerus may be subdivided into a number of zones such as the proximal end, the medial shaft, the lateral edge of the medial shaft, the distal end, etc. The researcher then counts the number of bones comprising each zone rather than the bone as a single unit. O'Connor (1989) provides further information.

Other methods of quantification, including MNE, MAU, MUI, MGUI, Lincoln Index MNI, etc., could not be used in this report. They were not reported for any site, and were too difficult, if not impossible to calculate on the basis of the data available.

The overall focus of my research is to obtain a clearer picture of the relative contribution of the animal (especially mammalian) taxa represented that will reflect their importance in the economy and diet of Roman Italy. As such, I rely not so much on the actual values and frequencies given by NISP and MNI statistics for the animal bones collected at each site, as on the ordinal ranking and relative abundance of each taxon in comparison with other taxa both within and between sites. Neither NISP nor MNI counts should be considered absolutes, but each may be used in order to provide an approximate view of the variation in taxonomic abundance between sites, provided the criteria for their calculation remain consistent. Since I was dealing principally with mammals, all of which generally contain the same number of identifiable bones (except for minor dental and metapodial differences), I chose NISP as a quick and efficient indicator of species abundance and rank. As noted above, NISP was the only quantifying variable used for a number of sites reported in this analysis. Therefore, in the absence of other markers I must rely solely upon NISP comparison for these sites.

NISP Analysis

Table 16 lists the frequency of individual mammalian taxa according to NISP figures. The sites are ordered according to geographic region, temporal period, and site type, again beginning with S/1/r[30] sites and progressing to N/3/u2 sites. Several sites with deposits which date to different time brackets within a temporal period have been broken down into their component parts (e.g., Gravina has been divided into 7th-2nd BC deposit and 2nd BC-1st AD deposit). Subdivided phases are noted in parentheses.

With a few exceptions, most notably several of the special sites, the data from Table 16 indicate that cattle, sheep/goat and pig command the greater NISP values. Generally, pigs display the highest percentages, followed by sheep/goats and cattle, although there are fluctuations in this ordering. Sometimes cattle are more frequent that pigs. In any event, the predominance of these three taxa at nearly every site underlies their importance in the Roman economy and diet. The contribution of cattle, sheep/goats and pigs will be examined in detail later.

Aside from recognizing the predominance of cattle, sheep/goats and pigs, it is difficult to determine broad patterns in the data from Table 16 without clustering the sites into smaller groups. Figures 7 and 8 present the mean frequencies for the eight mammalian categories (i.e., cattle, sheep/goat, pig, equid, dog, cat, wild mammals, and rodents) in Table 16 with sites grouped by shared region, time period and site type. Only sites with total mammalian

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[30] Abbreviations will be used to designate geographic region/temporal period/ site type groups. "S/1/r" stands for Southern Italy/Period 1/rural sites, "N/3/u2" abbreviates Northern Italy/Period 3/ urban2 sites. See the list of abbreviations for "zooarchaeological data" at the beginning of this thesis for full codes.

NISP figures greater than 100 are included; the number of sites comprising each category is given in each case. Figure 7 is a stacked bar graph of the mean NISP frequencies for the principal mammalian taxa (i.e., cattle, sheep/goat, and pig), while Figure 8 displays the remaining mammalian taxa. Special sites have not been included in either Figure 7 or Figure 8.

MNI Analysis

Table 17 lists the frequency of individual mammalian taxa according to MNI figures. The sites are ordered according to geographic region, period and site type. Considering the biases associated with NISP statistics (outlined in Chapter 3), I felt it necessary to compare the sites on the basis of MNI values as well. Unfortunately, MNI values were calculated at fewer sites (62 sites, or parts thereof, with MNI values, compared to 100 for NISP), and these values themselves are not without biases. The method of MNI computation is not always the same for each site. Some sites incorporate aging criteria, others combine layers and periods and deposits to obtain a general MNI for the entire site, while others separate out different phases, layers, deposits, etc. then sum each of these individual MNI values for a grand total. I was not too concerned with the MNI method used at each site, since this could not be controlled. My primary purpose was to study the data trends produced by the figures, and not so much the individual values. In addition, I wanted to see if the patterning produced from the MNI comparisons differed from that of the NISP statistics.

Figures 9 and 10 plot the mean MNI frequencies for various clusters of sites, in the same manner used for the NISP figures above. Figure 9 shows just cattle, sheep/goat, and pigs, while Figure 10 depicts the remaining taxa. Only sites with total mammalian MNI figures of ten or more are included, the number of sites comprising each category listed after the category name.

The data from Tables 16 and 17 as simplified in Figures 7 through 10 reveal several trends, which I shall outline for individual taxonomic groups:

Cattle, Sheep/Goats, and Pigs

Cattle, sheep/goats, and pigs dominate both NISP and MNI frequencies at practically every site, and certainly within all rural, urban1, and urban2 groupings. While there are some minor discrepancies between the NISP and MNI figures recorded for each individual site, overall there is no dramatic variation between NISP and MNI patterns for the groups of sites shown in Figures 7 - 10.

Both NISP and MNI mean frequencies for cattle and sheep/goats drop substantially for rural sites in southern Italy from earlier periods to later periods, while pig frequency values increase significantly over the same time frame. Southern Italy, in fact, shows the greatest change in these values, with some statistics nearly doubling (note MNI for pigs), while others are cut almost in half (compare S/1/r and S/2,3/r values for cattle). Urban sites in southern Italy record far more cattle, and much less pig than their rural counterparts.

The cattle, sheep/goat, and pig pattern amongst sites in central and northern Italy generally shows fewer dramatic fluctuations compared to southern Italy. The overall frequency of cattle at rural sites in central Italy reduces over time. Sheep/goat frequencies decline from Period 1 to Period 2, concomitant with a rise in pig values; however, the reverse is displayed from Period 2 to Period 3 (i.e., sheep/goat increases and pig decreases). Although urban sites in central Italy exhibit much the same standard pattern as their rural counterparts, there are more discrepancies between NISP and MNI figures. NISP values for cattle record an increase then a decrease over time, but corresponding MNI values show the opposite. Similarly, NISP figures for pigs increase from Period 2 to Period 3, while their MNI values mark a decrease over the same temporal period.

Cattle are especially predominant amongst sites in northern Italy, regardless of the time period. Northern Italy claims three of the four highest percentages of cattle bones amongst all site types. The frequency of cattle for urban type sites in northern Italy decreases from Period 1 to Period 2 (less marked in MNI values) then increases sharply in Period 3. Sheep/goats follow a reverse pattern (i.e., increase from Period 1 to 2, then decrease from Period 2 to 3), while the frequency of pigs hovers around 31% regardless of period or quantifier. There is less data available for rural sites in northern Italy, but what are available show a fairly high frequency of pig bones (47.3%, NISP) with a much smaller value for cattle (19.5%, NISP) for Period 3 in particular. The data indicate that pigs were more important at rural sites in northern Italy than at urban sites.

Equids

Overall, equids account for less than 7% of the bones, using either NISP or MNI counts. Although equids are most frequent at urban type sites in southern Italy, generally rural sites, regardless of time period or location, hold higher values than urban sites. The frequency of equids declines from Period 1 to Periods 2 and 3 in southern Italy. Equid values rise amongst rural sites in central Italy from Period 1 to Period 3, but tend to decline at urban sites (at least according to MNI values) over the same time frame. Finally, northern Italy records many of the lowest frequencies for equids amongst all sites. The overall pattern here shows a decrease in equids from Period 1 to Period 2 which is countered by an increase in Period 3.

Dogs

Dogs, like equids, typically account for less than 7% of the bones, using either quantifier. There are some exceptions but, in general, the frequency of dogs is higher at rural sites compared to urban sites. Dogs are also more prevalent at sites in southern and central Italy as opposed to those in the north. The clearest pattern is a progressive increase in both NISP and MNI mean frequencies from Period 1 through to Period 3 for rural sites in central Italy. An increase is also noted in the frequency of dogs at urban sites in central Italy from Period 1 to Period 3, although this declines from Period 2 to Period 3. The pattern for southern Italy varies on the basis of NISP or MNI statistics. NISP values reveal no change in the frequency of dogs at rural sites in the south from Period 1 to Period 2, but corresponding MNI numbers show a marked decline over the same time. Finally, northern Italy holds many of the lowest dog NISP values and the lowest dog MNI values amongst all categories of sites shown in Figures 8 and 10, and the data show that these animals figure less over time. The mean NISP frequency of dogs drops from 1.5% in Period 1 to a mere 0.1% in Period 3 (MNI drops from 2.5% to 0.8%).

Cats

Cats are infrequent finds at most of the sites. They do not even register amongst the summary statistics for sites in northern Italy which all record 0%. Southern Italy does not fare much better. Here, cats account for 0.1% of the NISP frequency at urban type sites from Period 1, and 0.3% of the MNI value (or 0.03% of the NISP, which does not display at one decimal place) for rural sites of Period 2/3. The data indicate that cats appear first in southern Italy, then spread to central Italy, but never become prevalent in the north. Cats comprise a small percentage of the bones at rural sites, and their frequency increases slightly from Period 2 to Period 3 amongst these sites in central Italy. However, it is Period 3 urban sites in central Italy which record the highest frequency of cats (1.0% NISP and 4.1% MNI).

Wild Animals

Several trends are visible from the NISP and MNI frequencies for wild animals. First, rural and urban2 type sites, regardless of time period or region, generally record much higher values for wild animals than urban1 sites. Second, there is an overall decline in wild animal frequencies over time regardless of site type. This pattern is best evident in the MNI values, especially at rural sites. Rural sites in southern Italy drop from 12.1% to 8.6% from Period 1 to Period 2/3; rural sites in central Italy decline from 18.9% (Period 1) to 15.6% (Period 2) to 12.0% (Period 3); rural sites in the north fall from 11.5% to 6.6% then 1.1%, over a similar time period. Finally, wild animals are generally more prevalent at sites in central Italy, and least common in the north.

Rodents

Rodents generally account for less than 3% of the NISP from a site, but in many cases the figure is below 1%. They are more abundant at rural sites as opposed to urban sites, and are particularly numerous at rural sites in southern and central Italy. Northern Italy records some of the lowest frequency values for rodents.

Tables 18 and 19 summarize findings further by grouping sites according to site type and presenting the mean NISP and MNI frequencies for each mammalian taxon. In this manner, the overall faunal patterning of rural, urban1, urban2 and special sites in terms of taxon abundance can be compared. Only sites with NISP and MNI totals greater than 100 and 10 respectively have been used.

Regardless of quantifier, it is clear from Tables 18 and 19 that pigs dominate at rural sites, followed by sheep/goats, cattle or wild animals, dogs, equids, rodents, and cats, in that order. The same pattern, at least for the first three taxa, is found at urban1 sites, although some values here (most especially pig) tend to be a bit inflated compared to rural sites, while corresponding equid, wild animal, and rodent figures are much lower. A different pattern is recorded for urban2 sites. Sheep/goat lead, followed somewhat closely by cattle or pigs, depending on which quantifier is used. Equids are more common amongst rural and urban2 sites than at urban1 sites, a pattern which is consistently demonstrated for both quantifiers. NISP and MNI values conflict in the case of dogs. NISP frequencies record a strong predominance of dogs at rural sites over urban1 and urban2 sites, while MNI values show urban1 dogs ranking higher than the other two. Urban1 sites claim a greater frequency of cats compared to rural and urban2 sites. The overall frequency of wild animals is greatest at rural sites and least at urban1 sites. Rodent frequency statistics show a similar pattern: highest at rural sites, and much reduced amongst urban1 and urban2 sites.

Although NISP and MNI values vary for special sites, the general pattern is quite different than that shown for rural or urban sites. "Minor" urban and rural mammals such as dogs, equids, and cats figure prominently amongst special sites, while the frequency of principal domestic taxa such as sheep/goat and pigs is much reduced. Cattle account for just over 21% of the NISP and about 15% of the MNI at special sites, while wild animals and rodents make very small contributions to NISP and MNI totals.

Production and Consumption

Although zooarchaeological data from Roman period sites in Italy indicate a variety of mammalian taxa, not all of these were consumed. Since the focus of this study is production and consumption of mammals in Roman Italy, I shall concentrate subsequent analysis on those taxa that were consumed, or supplied products that factored in the Roman diet. This excludes equids, dogs, cats, and rodents. The Romans normally did not feed on equids, dogs, or cats, but each certainly fulfilled important roles in non-dietary aspects of ancient life. Equids served many duties—riding, draft, racing, cavalry, etc.—some of which were integral components in the multi-faceted sphere of Roman production. However, with only the odd exception, horses, donkeys, and mules provided no resources for the Roman diet. The situation is the same for dogs and cats. Dogs were variously trained as guards, protectors, companions, and pets, but were never raised to be eaten, at least not in Roman Italy. Cats had fewer duties compared to dogs, yet they too were not consumed as food. Rodents served no productive function and were not normally eaten. One exception to this was the dormouse which I have chosen to include amongst consumed wild animals rather than in with rodents. Since equids, dogs, cats, and most rodents were not eaten during Roman times in Italy, none of these taxa will be considered further in this thesis. Additional information about them can be found elsewhere. Keller (1909, 1913) supplies much material specific to the Romans in his volumes about animals in the ancient world, but his research does not consider zooarchaeological data and is somewhat dated. Toynbee (1973) discusses the role of equids, dogs, and cats, amongst other animals, in Roman life. Lefebvre des Noëttes (1931), Vigneron (1968), Azzaroli (1985), and Hyland (1990) concentrate specifically on equids; Merlen (1971) and Thurston (1996) discuss Roman dogs; Bodson (1987), Lentacker and de Cupere (1994), and Engels (forthcoming) devote attention to the cat in antiquity. A couple of articles detail aspects about rodents in Roman times (Audoin-Rouzeau 1994; Masseti 1995). Of all the mammalian taxa known in antiquity, only cattle, sheep/goats, pigs, and various species of wild (and sometimes exotic) animals contributed resources for the Roman diet in Italy. The remainder of this thesis will be dedicated to their analysis.

Zooarchaeological quantifiers such as NISP and MNI indicate that the three taxa of domestic mammals—cattle, sheep/goat, and pig—predominate over wild mammals at nearly every site. The importance of cattle, sheep and goats, and pigs to the Roman economy and diet cannot be understated. There are numerous textual references concerning each, and a large body of zooarchaeological data to consider as well. Each taxon will be considered individually in subsequent chapters of this thesis.

Chapter 5

RESULTS: PRODUCTION

Part 1: CATTLE

Zooarchaeological Data

Identification and Quantification

Of all the sites used in this analysis, cattle bones were recovered from 93.3% of the rural sites, 100% of both types of urban sites, and 73.3% of the special sites. While there are some minor discrepancies between NISP and MNI figures, overall there is no dramatic variation between NISP and MNI patterns.

Figure 11 displays the calculated mean values of the various NISP and MNI frequencies for cattle according to site type, while Table 20 lists the range, variance, standard deviation and sample size for these. Only sites with total NISP and total MNI values of 100 and 10, respectively, have been used in these calculations.

Although there is considerable variation in the mean NISP and MNI frequencies for cattle, particularly among special sites, the general pattern records a mean frequency for cattle of between 10-12% of the total mammalian NISP and MNI values at rural and urban1 sites. Urban2 sites register mean values between 20-30% and contain over twice as many cattle remains and individuals than either rural or urban1 sites, regardless of which quantifier is compared. Cattle are also quite prominent amongst special sites, averaging 32.6% of total NISP figures but only 18.2% by MNI.

Figure 12 shows the mean relative frequency of cattle remains calculated on the basis of NISP and MNI values, but with the data broken down into temporal, geographic, and site-type clusters. Special sites are not included in Figure 12. Only sites with NISP grand totals greater than 100, and MNI grand totals greater than 10 are represented.

Both NISP and MNI mean frequencies for cattle drop substantially for rural sites in southern Italy from earlier periods to later periods. In fact, southern Italy shows the greatest change in these values—some are reduced by nearly one-half. Urban sites in southern Italy, however, generally record much more cattle than their rural counterparts.

The relative frequency of cattle amongst sites in central and northern Italy typically shows fewer dramatic fluctuations compared to southern Italy. The overall frequency of cattle at rural sites in central Italy reduces over time. Although urban sites in central Italy display much the same standard as their rural counterparts, there are more discrepancies between NISP and MNI figures. NISP values for cattle record an increase then a decrease over time, but corresponding MNI values show the opposite pattern.

Cattle are especially predominant amongst sites in northern Italy, regardless of the time period. Northern Italy claims three of the four highest percentages of cattle bones amongst all sites used in this thesis. The frequency of cattle for urban type sites in northern Italy decreases from Period 1 to Period 2 (less marked in MNI values) then increases sharply in Period 3. There are less data available for rural sites in northern Italy, but what are available show a small value for cattle (19.5%, NISP) for Period 3 in particular.

Age

A summary of the fusion data for cattle is presented in Table 21, with the complete data listed in Appendix 3. The data in Table 21 are arranged according to site type, with the number of sites comprising each fusion category given in parentheses. Only sites with fusion data sample sizes of at least 10 have been used in this analysis. Values indicate the mean frequency of bones with unfused epiphyses. Thus, "4.2" in the 7-10 month category means that 4.2% of the bones with epiphyses that fused between 7-10 months had unfused epiphyses, or, in other words, 4.2% of cattle were younger than 7-10 months of age.

Table 22 presents the mean frequency and range of cattle at various ages calculated on the basis of dental data. Again, only sites with dental age sample sizes of at least 10 have been used in this table. The complete list of all individual sites including information on which method(s) for dental aging was used, as well as sample sizes for each is given in Appendix 4.

Finally, Appendix 5 provides comments made by researchers about the relative frequency of cattle bones at various age stages such as juvenile, subadult, adult, old age, etc. In some cases numeric percentages are given, while in other cases this is expressed as some relative term (e.g., "many," "most," "few," etc.).

Sample sizes are quite small in most cases; therefore any interpretation about patterns in cattle ages requires caution. Nevertheless, a review of Appendix 5, and Tables 21 and 22 shows that the majority of cattle died at older ages, regardless of site type. "Most" to 90% to "all" of the cattle at rural sites were adults, based on records in Appendix 5. According to the fusion data, c. 24% of the cattle amongst rural sites and c. 35% of the cattle amongst urban1 sites were killed before 42 months of age. This implies that c. 76% of the cattle amongst rural sites and c. 65% of the cattle amongst urban1 sites lived beyond 3.5 years. The dental data generally agree with this pattern. Combining the three dental categories 36+, 48+, and 60+ months as one age group (i.e., 3+ years) yields values of c. 80% for rural sites and c. 69% for urban2 sites. Thus, dental evidence indicates that c. 80% of cattle amongst rural sites and c. 69% of cattle amongst urban2 sites survived beyond three years of age.

At the opposite end, the data from Appendix 5, Table 21, and Table 22 show that a larger number of younger calves, less than one year old, were killed at both types of urban sites compared to rural sites. Juvenile and subadult cattle preponderate at urban1 sites, according to Appendix 5, but are much less common at rural sites. According to the fusion data, on average c. 23% of bones with epiphyses that fuse within 7-10 months of age were below that age amongst urban sites, while rural sites registered a much smaller mean of

4.2% for the same age bracket. The corresponding dental data show a smaller difference between average values for the number of cattle less than one year, but they still indicate that younger calves were relatively more common amongst urban sites. Nearly 10% of the sample of cattle teeth from urban sites lies in the 0-6 and 6-12 month categories, with about 7% in the same age groups at rural sites. Very few cattle appear to have been killed during their second year of life. Fusion data indicate that, regardless of site type, less than 10% of the bones in 12-18 month fusion category were unfused, with rural sites again recording a very low value (i.e., fewer younger cattle). Dental data support this pattern. Few cattle fell within the 15-18 month category, while none could be aged at 18-24 months, on the basis of available dentition.

Age patterns for sites with dental and fusion sample sizes less than 10 roughly parallel the examples outlined above. According to these dental data (17 sites had less than 10 cattle teeth which were aged, see Appendix 4), adult cattle were prevalent at most sites, but particularly dominant at rural sites. More younger cattle are recorded at urban sites than rural sites, while special sites have a mix of ages, specific to the character and function of each. For example, Volano, a site linked with hide processing, has predominantly adult cattle, while Campochiaro, a site where cattle sacrifice is thought to have occurred, has chiefly younger animals.

Seasonality

The cattle aging data show no distinctive pattern of seasonal slaughter. As outlined above, most cattle were killed at older ages, but the dental categories beyond 24 months of age are not specific enough to determine seasonal patterns. Although each dental age category beyond the 24 month limit does in fact span one year (i.e., 24-36 months equals one year, 36+ months to 48+ months equals one year, etc.), which suggests some type of annual slaughter, it is impossible to know when within that year an animal was killed, or if there was a seasonal cull.

Sex

Table 23 lists the number of cattle bones for which sex was determined and the corresponding percentages of males (bulls), oxen (castrated males), and females (cows). Indeterminate male/ox and female/ox categories are also included. In most cases the bones that were sexed include the horn cores and pelvis, and to a lesser extent the metapodials. The sites are arranged according the geographic region, time period, and site type, starting with southern Italy.

Two things must be considered. First, sample sizes vary tremendously; over half of the sites listed above had less than ten cattle specimens that were sexed. Second, the data are heavily biased towards sites in northern Italy, which is not surprising considering that cattle dominate NISP and MNI frequencies in this region (see Figures 7 and 9). Nevertheless, with the exception of Torcello, which has a very small sample size of only two, the data indicate that bulls are uncommon amongst these sites. Oxen predominate bovine tallies at San Giovanni-period 2, Pompeii Ganimede, Stufels-Hotel, Volano, Altino, and Aquileia; however, cattle sample sizes are also quite small for the first four of these sites, while that from Aquileia derives from a special deposit of almost exclusively horn cores, and may not be totally representative of the cattle economy of the area. Finally, cows comprise the bulk of the cattle bones which could be sexed from the remaining six sites in Table 23. With the exception of San Giovanni-period 3 all of the sites are located in or near the mountainous regions of northern Italy.

Bone measurements can assist in distinguishing sexes. In general, the bones of bulls are slightly longer and a lot broader than those of cows, while those of castrates tend to be long (Grigson 1982a: 10). Measuring the length of a long bone and plotting it against the breadth can help in determining sex. There has been little research on sexing cattle limb bones, apart from the metapodials. This is of no great concern to my present analysis since from all the Roman sites in Italy less than ten limb bones of cattle (not including metapodials) are complete enough for their length to be measured. The metapodials, however, are a different story. The overall shape of cattle metapodials as measured by two indices (Bd/GLx100) and (SD/GLx100) varies with sex.[31] Howard (1962, 1963) and Maltby (1979) have shown that cows generally have metacarpal Bd/GLx100 values of less than 30, while those for bulls and steers are greater than 30. Metatarsal Bd/GLx100 values less than 25 usually belong to cows, while above that signifies a bull or steer. There is much more overlap between the sexes in SD/GLx100 values, but anything less than 15 for metacarpal and 12 for metatarsal normally denotes a cow, while a figure greater than 18 for metacarpal and 13 for metatarsal usually signifies a steer or bull. These ratios measure shape; therefore, as long as the cattle being compared are of the same breed, there is no need to standardize for variations in size. Fock (1966) and Higham (1969) have also shown that cows can be separated from bulls and steers on the basis of metapodial distal breadth measures. Histograms of breadth measurements, if they include both males and females, should be bimodal. Hodgson (1977: 23) and Albarella and Davis (1994b), however, caution that metapodial widths can undergo a degree of alteration (generally an extension of the medial condyle) if cattle are subject to excessive stress such as that induced by ploughing or traction.

Sixty-three cattle metapodials (33 metacarpals and 30 metatarsals) from Roman period sites in Italy survive in a complete state, and were reported with measures. I calculated two variables using these metapodial measurements, Bd/GLx100 and SD/GLx100, to determine sexual differences. Using the metapodial indices, I am able to add several more sites to the list containing sexed cattle bones. These additions are given in Table 24.

These additional data support what is already shown in Table 23: bulls are very uncommon, oxen and cows predominate. Furthermore, the data indicate that cows comprise the bulk of the sexed bones from sites in northern Italy and in Campania (Carminiello as example of the latter), while oxen contribute more bones at sites elsewhere.

Figures 13 to 18 plot metapodials distal breadth measures according to time period and region. Figures 13 - 15 present data for cattle metacarpals, while Figures 16 - 18 those for metatarsals. The data from Figures 13 to 18 depict several trends. First, there is a progressive size increase from Period 1 to Period 3. The average cow, ox, or bull from

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[31] Measurement abbreviations follow von den Driesch (1976): Bd=maximum breadth of the distal end; GL=maximum length; SD=smallest breadth of the diaphysis.

Period 3 is larger than its earlier equivalent. I will discuss this more in the "size" section of this chapter. Second, measurements for each of the three regional groups are fairly evenly distributed across the graphs, suggesting that we are dealing with a single breed of cattle, or at least breeds whose size did not vary considerably. Thus, if southern cattle were in fact a different breed than those of the north, then the data indicate that they were still of similar size, at least within the same time period. Third, there is some bimodality amongst the plots. However, there is also a good deal of size overlap between the sexes, especially within the metatarsal plots. Bimodality is clearest in Figure 13, and somewhat evident in Figures 15 and 18. According to Figure 15 the mean metacarpal Bd values for female cattle is near 58 mm, while the mean for males is around 68 mm (Compare this with female and male means of 52 mm and 64 mm, respectively, in Figure 13 to see size increase). Corresponding metatarsal means from Figure 18 are: females—53 mm, males—63 mm. Finally, assuming the impact of breed sizes in negligible, the data indicate a fairly equal balance of male and female cattle amongst the combined sites for southern and northern Italy during Period 1, but a preponderance of males (probably oxen) at sites in central Italy during the same time. During Period 2, cows appear to outnumber oxen in central Italy, while northern Italy continues with a reasonably balanced male/female ratio. The pattern in Period 3 again shows a fairly even distribution of males and females for northern Italy. However, the metacarpal plot displays a greater frequency of cows in southern Italy, while the metatarsal plot depicts a preponderance of male cattle in central Italy. These patterns are not evident in the converse plots (i.e., metacarpal for north, and metatarsal for south—both of which display a greater balance between the sexes).

There have been some attempts to distinguish between male and female cattle on the basis of measurements of the astragalus and calcaneum (Müller 1959; Dürr 1961). A great number of these bones survive from Roman period sites in Italy, and have subsequently been measured. However, I have not used these to distinguish sex. The absence of comparable material of known sex sheds doubts on the reliability of the results from such tests (Grigson 1982a: 10).

Although Higham (1969) and Stampfli (1976) demonstrated dimorphism in their samples of modern and Neolithic cattle phalanges, respectively, this technique requires the separation of phalanges between the fore and back foot. Researchers have only rarely made this distinction for cattle phalanges from Roman period sites in Italy; therefore, I have not used this technique to determine cattle sex in this thesis.

Finally, there are insufficient data from these sites to test for sexual separation of cattle teeth using Beasley, Brown, and Legge's (1993) methodology. The cervical length of the first and second molar was not one of the measurements commonly recorded at nearly all of the sites listed. In most cases only the third molar was measured. Furthermore, in the absence of good information about the breed(s) of cattle at each site, I am not convinced that Beasley, Brown, and Legge's (1993) approach would be applicable to my sample.

Age and Sex Correlation

It is difficult to correlate the age and sex data for cattle from Roman periods sites in Italy because the two were generally calculated using different sets of bones. Dental eruption and wear patterns provided fairly detailed information about age, but teeth could not be used to distinguish sex, owing to great variability in their size with no distinctive bimodal (or trimodal, if castrates indeed separate from males) patterning. Measurements of certain long bones, once plotted, can help to distinguish size separation between the sexes (see the discussion on metapodials above), but such tests are limited to those bones with fused epiphyses, and therefore only tell us about the sex of mature animals.

Table 25 attempts to relate the information on cattle age and sex. Four broad categories are recognized: young males/oxen, older males/oxen, young females, and older females. The relative frequency of each category is denoted by a range of "•," with no "•" (i.e., blank space in column) meaning total absence, and "••••" indicating a great abundance. For those sites without dental aging data, fusion data were used instead. These cases are noted in the "sample size aging" column.

As shown in Table 25, only 16 sites (or parts thereof) provided information about the age and sex of cattle, too few to draw any significant conclusions. This problem is further complicated by the fact that sample sizes are quite small for all but a couple of sites, and that the data are biased towards sites in northern Italy. Despite these difficulties, however, the data in Table 25 generally indicate a predominance of older cattle, both males and females, amongst all sites. Older oxen outnumber mature cows by ratios of around two or three to one at many sites where the two co-exist. However, three sites—San Giovanni-period 3, Pozzuolo del Friuli, Innichen—contain significantly more older cows than oxen, a pattern which implies some degree of dairying.

The data in Table 25 hint that young cattle, both males and females, comprised a small part of the sample amongst urban2 sites, but they are also present at select rural, urban1, and special sites. Moreover, the data reveal no distinctive pattern in cattle age and sex ratios amongst site types, which contrasts with the evidence from fusion data in particular, which indicate a significant percentage of young calves at urban sites (see Table 21).

Size

Rather than complicate this present analysis of size with numerous charts of many possible measurement as outlined by von den Driesch (1976) arranged in different ways according to geographic area, temporal region, and site type, I have chosen to limit my study of cattle size variation to an analysis of withers height. I shall concentrate on temporal and geographic variation in size, assuming negligible size differences in cattle amongst site types.[32] Movement of animals and cuts of meat between contemporary rural and urban centres, with concomitant mixing of bones, complicates the recognition of any size variation patterning specific to a site type.

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[32] Estimated withers heights for rural and urban cattle in central Italy (using solely the metapodial bones) are not markedly different (i.e., rural: 217.6 cm [n=3]; urban1: 216.7 [n=3]). However, there are limited metrical data to test this assumption for the different site types in southern and northern Italy. No withers heights are available for urban sites in southern Italy (i.e., no measurements for long bones recorded or no complete long bones recovered), while only a single withers height estimate is available for rural sites in northern Italy (from Monte Barro). This contrasts with the situation for Roman Britain where Thomas (1989: 120) notes a significant difference in the average size of urban and rural cattle. Here, mean values for cattle withers heights at rural (i.e., producer) sites are larger than their equivalents from urban (i.e., consumer) sites. However, Thomas (1989: 120) further comments that the ranges for both site types are very similar, which might indicate that these size differences between urban and rural sites may not have been very marked.

Table 26 lists the range, mean, variance, standard deviation, and sample size and composition for withers height calculations for cattle on the basis of Matolcsi's (1970) factors. Matolcsi provides different factors for male and female metacarpals and metatarsals. I applied these to only those metapodials for which a sex had been reported, and did not attempt to determine sex for others. In the case of complete metapodial bones where a sex was not assigned by the original zooarchaeologist, I used the mean value of the male and female withers height multiplication factors given by Matolcsi (6.19 for metacarpals [i.e., mean of 6.05 + 6.33] and 5.45 for metatarsals [i.e., mean of 5.28 + 5.62]).

The data from Table 26 show a general increase in the size of cattle over time. The change is clearly marked among sites in northern Italy where the mean withers height of 114.8 cm during Republican times climbs to 119.8 cm for the Imperial period and then to 121.8 cm during Late Antiquity. The data from the other regions are limited, and their patterns are not always consistent with that displayed for northern Italy. The mean withers height values for cattle in central Italy also increase over time, from 124.4 cm in Period 1 to 129.1 in Period 2, but no data are currently available for Period 2 in this area. The situation is reversed in southern Italy where the data show Imperial period cattle to be much larger than their Late Antique equivalents; however, these results should be viewed with caution since they are based on very small samples from only a single site, San Giovanni.

In terms of geographic variation, the data from Table 26 indicate that the average-sized cattle from northern Italy consistently fall below all other mean values. Their minimums and maximums are the lowest, with the exception of one large individual from the northern Italy/Period 2 group which registered an estimated height 150.1 cm. This pattern suggests that smaller cattle were generally kept amongst sites in northern Italy, while larger individuals inhabited central and southern locales.

While cattle may increase in size over time at these Roman period sites in Italy, the broad ranges and high standard deviations suggest a considerable variation within each group. A span of over 35 cm separates the largest and smallest cattle from the Late Antique central Italy sample, while that from Imperial period northern Italy is nearly 50 cm. Sexual size dimorphism certainly contributes to some of this variation. Genetic, dietary, and health factors also play a role; however, even combined it is unlikely all of these factors can explain the dramatic size range of these Roman cattle. Rather the data support the hypothesis that the Roman Italians raised different breeds of cattle—some larger than others. Moreover, they indicate that smaller breeds of cattle were not eliminated during Roman times, despite the general increases in size presumably caused by the introduction of new, larger breeds, and improvements in breeding schemes.

Abnormalities

Table 27 lists the incidence of non-dental abnormalities in cattle amongst Roman period sites Italy, while Table 28 records dental abnormalities. Sites are arranged according to region, time period, and site type.

There are always complications in reviewing the incidence and prevalence of pathological conditions in animals on the basis of osteological evidence. Numerous diseases will leave no osteological traces, thus rendering them indeterminate in the faunal record. Moreover, many of the pathological disorders shown on bones can be attributed to multiple causes or diseases. There is not always an easy connection between the symptom and its cause, and considerable caution should be exercised in examining animal palaeopathology. Add to this the variation amongst zooarchaeologists in recognizing and reporting skeletal abnormalities and it becomes quite difficult trying to identify patterns in the data. Despite these complications and considerations, some general observations about the health of cattle during Roman times in Italy can be made on the basis of the data in Tables 27 and 28.

The paucity of skeletal and dental abnormalities and pathological conditions, as shown in Tables 27 and 28, supports the hypothesis that most cattle in Roman Italy were generally in good health. The most common ailment is osteoarthritis causing extoses and/or eburnation in the bones of the lower leg, especially the metapodials and phalanges. Although the available data indicate no patterning in this, or any other abnormality, amongst the site types, the fact that this condition is shown only in cattle from southern and central Italy suggests a greater use of plough and work cattle in these areas. Sample sizes are too small, however, to test this statistically.

Textual Data

There are more references among the agricultural writers to cattle than to any other animal. They were regarded in high esteem as "a partner in labour and in husbandry" (Plin. *NH* 8.70.180), and as a component of practically all farms (Plaut. *Most.* 1.1.35). Indeed, Italy was thought to have derived its name from the word for bull-calves, "*vituli*" (Varro *Rust* 2.1.9) or "*vitali* " (Varro *Rust.* 2.5.3), while the word for money "*pecunia*" originated from that for cattle "*pecus*" (Col. 6.praef.4; Ov. *Fast.* 5.280-281; Varro *Rust.* 2.1.11). These etymological derivations imply some degree of prestige, wealth, and/or importance attributed to cattle raising during early Roman times.

Cattle were bred for their working capacity and for their appearance. Sturdy oxen, and on rarer occasions cows or barren cows (Col. 2.3.1-2, 6.22.1) pulled ploughs and other draught implements (especially on the lighter soils in Campania [Varro *Rust.* 1.20.4], while quality and attractive stock were often reserved for sacrificial purposes, or were chosen as breeding stock in larger cattle-raising schemes. Aelian (*NA* 2.57) summarizes the role of cattle well:

> [Cattle] are after all the most serviceable creatures. At sharing the farmer's labours, at carrying loads of various kinds, at filling the milk-pail—at all these things [cattle are] excellent. [An ox] graces the altars, gladdens

> festivals, and provides a solemn banquet. And even when dead the ox is a splendid creature deserving our praise.

The authors do not always distinguish between cows, bulls, and oxen. Columella gives the most detail, stating that bulls differ from oxen in having a fiercer expression, shorter horns, and a more brawny neck (Col. 6.20.1), while the best cows are tall, long, large-bellied, short legged, broad in the forehead, and compressed in the cheeks (Col. 6.21.1). Oxen generally receive the most information. Several varieties of cattle (usually in the context of oxen) are described by Columella (6.1.1-3), Pliny (*NH* 8.70.179), Varro (*Rust.* 2.5.10), and Strabo (6.1.1-2), but there are no references to cattle breeds in other works, including Cato and Palladius. Six Italian types are mentioned. Campania generally produces small cattle which are still strong enough for light cultivation (Col. 6.1-3). Umbria breeds two varieties: a rather large type, generally white in colour, and a smaller, red breed (Col. 6.1.1-3). Ligurian cattle are small (Col. 6.1.1-3; Varro *Rust.* 2.5.10), and according to Strabo (4.6.2) some of these were even sold at the port of Genoa and shipped to Rome. Etruria and Latium breed thick-set and powerful cattle, neither type of which is really distinguishable from one another (Col. 6.1.1-3), while those from the Apennines are tough but relatively unattractive (Col. 6.1.1-3). Strabo (5.3.1) notes that the Sabini area in the Apennines of central Italy is especially important for its domestic cattle of every kind. Regardless of the region, quality oxen were said to have large straight limbs, wide foreheads, long and muscular necks, huge shoulders, and long, squarish and black horns (Varro *Rust.* 1.20.2, 2.1.14; Col. 6.1.3).

Oxen were bred primarily as working animals, trained to pull the plough (Varro *Rust.* 1.13.3, 1.20.1-3; Verg. *G.* 1.45, 1.65, 1.276&285, 2.541-542, 3.50; Prop. 2.25.6, 2.34-47-49, 3.5.5; Tib. 2.2.6-8, 13-14; Sid. Apoll. *Carm.* 5.578-580; Hor. *Epod.* 1.23-28, 2.59-64; Ov. *Fast.* 5.497-499, 516-517; Hor. *Odes* 3.13.11-12; Hor. *Epod.* 1.23-28; Hor. *Epist.* 1.14.40-43; Col. 6.praef.2); therefore, at least two were requisite at each farm that could provide sufficient grazing. Varro (*Rust.* 1.52.2) and Aelian (*NA* 4.25) further say that oxen can also be used to tread out the grain during the threshing season. Although oxen were exceptionally hard workers (Petron. *Sat.* 56), ploughing was stressful and tiring for many (Verg. *G.* 1.45; Prop. 2.25.6; Sid. Apoll. *Carm.* 5.578-580; Tib. 2.2.13-14; Hor. *Epod.* 1.23-28, 2. 59-64). Columella (2.3.1-2) even outlines a massage technique for oxen. Cato (*Agr.* 10.1-2) states that six oxen are needed for a farm of 240 *iugera*, and two for a vineyard of 100 *iugera*. Varro (*Rust.* 1.19.1), quoting the ancient agricultural expert Saserna, claims that one yoke of oxen is needed for every 100 *iugera*, but he also recognizes variability in this number depending on the land conditions (Varro *Rust.* 1.19.2). Columella (6.3.2) records that one farm-labourer is enough to look after two yoke of oxen, which on the same day either plough or graze alternately. Oxen should be purchased unbroken and should not be initiated to the yoke before their third year or after their fifth (Col. 6.2.1; Varro *Rust.* 1.20.1). Farmers were to avoid buying mountain varieties of oxen for work in lowland areas and vice-versa (Varro *Rust.* 1.20.2). Columella (6.2.1-15) and Varro (*Rust.* 1.20.2) detail training procedures for all types of oxen, from calm to vicious individuals. Pliny (*NH* 8.70.180) and Varro (*Rust.* 1.20.2) add that the best way to train an ox is to yoke it with one already broken in. Good care and proper feeding were essential (Cato *Agr.* 5.6-8, 54.1-5, 70-73, 102-103), since cattle are susceptible to a variety of ailments (Col. 6.3 - 6.19). Columella devotes 16 chapters to these topics (Col. 6.3 - 6.19)! which even include a monthly feeding schedule (Col. 6.3.4-8), while Lucretius (5.1131) warns farmers about the spread of plague amongst herds. Cato (*Agr.* 55.1) provides a menu for a yearly feed ration for a yoke of oxen, which includes 120 *modii* of lupines or 240 *modii* of mast, as well as 520 lbs of hay. He further advises farmers to sell worn-out oxen and blemished cattle (Cato *Agr.* 2.7).

Since the economy of the farm necessitated that working oxen labour regularly throughout the year, they were kept on the premises. Varro (*Rust.* 1.13.3) implies this by noting that cattle can drink from reservoirs at the farm after being brought back from plough duties. Moreover, he notes that stalled cattle could be readily available for work, and supply a convenient source of manure for the fields (Varro *Rust.* 2.praef.5). Their stables and stalls should be opened towards the south to allow for maximum warmth (Varro *Rust.* 1.13.1; Pallad. 1.73; Col. 6.22.1), and be covered with shingles, tiles, broom, or sedge (Pallad. 1.74). Leaves could be used as bedding if straw was scarce (Cato *Agr.* 5.8, 37.2). The interior of the stall should be paved with stones, gravel, or sand to prevent hooves from rotting (Varro *Rust.* 2.5.16; Col. 6.22.1). Incidentally, both Varro (*Rust.* 1.23.6) and Columella (6.12.2) refer to cattle shoes made of broom, perhaps a measure to reduce hoof rot. Cato (*Agr.* 4.1) advises that the latticed feed-racks provided in cattle stalls should be no more than a foot apart from each other so that cattle will not scatter their feed. Farmers were told to keep their oxen outdoors in the summer and inside during the winter (Col. 6.3.1); however, this only seems to apply to stalled cattle kept near the farm all the time.

Large-scale cattle raising was generally restricted to well-irrigated lowland valleys. Varro himself owned such a herd (*Rust.* 2.praef.6). In some cases they moved seasonally. Cattle were most conveniently pastured in lush grasslands near the coast during the winter and later brought to wooded country in the low-lying hills in the summer (Varro *Rust.* 2.5.11; Col. 6.22.2) Ovid (*Fast.* 5.639-640), Pliny the Younger (*Ep.* 2.17), and Propertius (4.9.14) praise the rich pastures just outside of Rome. According to Tibullus (2.5.25), cattle even grazed on the Palatine Hill in Rome in ancient times, although this is somewhat fanciful. The cattle of southern Italy also receive some attention. Virgil (*G.* 2.195-202) notes that the regions around Tarentum provide excellent plains for pasturing cattle. Lucilius (6.262-263, cf. Nonius 362.13) recognizes the strong bulls bred in the Lucanian mountains, while nearly 800 years later Cassiodorus (*Var.* 11.39) acclaims the cattle pastured in the fertile fields in the region of Bruttium (and notes how this region was taxed in kind for these resources which were destined for consumption in Rome). Black cattle were preferred because they were hardy; unlike working oxen, they could be kept out of doors year round (Varro *Rust.* 2.5.8). White cattle were considered rather feeble (Varro *Rust.* 2.5.8) and consequently rare (Juv. 7.202). Of the several breeds he mentions, Varro (*Rust.* 2.5.9-10) states that Ligurian cattle are the smallest, at least amongst the Italian breeds. Overall, however, Italian breeds are favoured for sacrifice, due to their size and colour (Varro *Rust.* 2.5.10). Pliny (*NH* 8.70.179) states that even the breeds less praised for their appearance (such as the Alpine cows) are not to be deemed inferior if they can serve other economic purposes. Columella (6.24.5) and Pliny (*NH* 8.70.179) note the unattractive low stature of Alpine cows but praise their capability to produce an abundance of milk. Shelter may have been provided for calving females since careful management and special care were required during pregnancy (Col. 6.23.1). Lucretius (2.352-365) tells of a mother cow who revisited her stall searching for her calf, who had been sacrificed. One poem in the Appendix Virgiliana (*Lydia* 28-30) notes that bulls and cows were put in separate stalls, the design of which was similar to that for oxen (Col. 6.23.1). Some bulls, however, were not contained, but rather allowed to wander freely through the forests (Col. 6.23.3).

Varro (*Rust.* 2.5.17) notes that cattle, like other animals, should be culled once a year. Those deemed unfit should be removed from the herd and presumably slaughtered, since they take up the room of those which can bring a profit. In addition, branding of cattle should take place on an annual basis. According to Columella (11.2.14) and Palladius (2.16) this was to occur in January, when there was little other work to do around the farm.

Herd sizes varied depending on the owner. Varro states 100-120 is reasonable, with sex ratios of two bulls per sixty (*Rust.* 2.5.18) or seventy (*Rust.* 2.5.12) cows. One bull is a yearling, the other a two year old (Varro *Rust.* 2.5.12). Columella (2.24.3) and Pliny (*NH* 8.45) claim one bull to every fifteen cows is more adequate. Breeding cattle was a serious business. Farmers were told to renew their stock continually by breeding, and to choose amongst these the best quality individuals for mating (Verg. *G.* 3.69-71). Bulls were thought to be the sole biological contributor in mating; therefore breeders chose sturdy and powerful ones in hopes of producing quality calves (Hor. *Odes* 4.4.29-31). Virgil (*G.* 3.51-59), however, adds that the ideal birthing cow should be fierce looking, with a long flank, large, long limbs, and crooked horns. Bulls were generally allowed to mate when they were between four and twelve years of age (Col. 6.24.1). Cows were not covered until two years old, but are better served at three or four years (Verg. *G.* 3.61); most continue to ten years (Varro *Rust.* 2.1.13, 2.5.13; Verg. *G.* 3.61). The longest life was fifteen years (Plin. *NH* 8.70.178). Bulls were strongest at five years, but can live to twenty (Plin. *NH* 8.70.178). Calves were castrated either as young individuals or as two year olds (Varro *Rust.* 2.5.17; Col. 6.26.1). Mating occurred in mid-June to mid-July so that calves were born ten months later (Varro *Rust.* 2.1.19) when the fodder crops were fully grown in the spring (Col. 6.24.1). Ovid (*Fast.* 1.155-158, 3.241-242, 4.100-106) claims that cattle give birth earlier in the year, around March, but later says that they are "big with young" during the Kalends in April (Ov. *Fast.* 4.633), which would imply mating around June or July. Furthermore, Pliny recommends (*NH* 8.70.177) that nations that live on milk (presumably referring to Alpine regions on the basis of Columella's [6.24.5] comments about the copious amount of milk produced by Alpine cows) stagger mating in their herd to achieve a constant supply. Virgil (*G.* 2.524-525) seems to agree with this when he notes that cows have milk-laden udders in the winter. As a rule, cows should have no more than six pregnancies or three per cow if following the biennial scheme proposed by Columella (6.24.4). Such a program was employed at farms where breeding cows performed other duties like pulling the plough (Col. 6.24.4; Pallad. 8.10). Generally, cows give birth to one calf at a time but there are some exceptions. Virgil (*Ecl.* 3. 29-30) admires a cow that "comes twice a day to the milking pail, and suckles two calves."

In terms of feeding, Cato (*Agr.* 54.5) suggests that working oxen should not be pastured except in winter, when they are not ploughing, in order to prevent them from nibbling on fresh growth. He gives a spring ration of 15 lb of hay plus 24 lb of mash per day (Cato *Agr.* 54.1-2). Columella (6.3) devotes much attention to the discussion of cattle diets, stressing the importance of green fodder, especially legumes, as well as quality pasture. Pasturing cattle should have available shade (Verg. *Ecl.* 2.8; Pers. 3.5-6). They could feed on grass but also, according to Horace (*Epist.* 1.16.9-10), on arboreal fruitage. In the summer, herds could be let out at daybreak (Acc. 509-512, cf. Nonius 395.11) into both fields and woods to pasture, being called home at dusk (Col. 6.23.2-3). In autumn, however, the farmer is advised to begin to prune the wood and to cut the fresh leaves to serve as winter fodder for the cattle (Cato *Agr.* 6.3, 30.1; Varro *Rust.* 2.5.14; Calp. 5.98; Plaut. *Most.* 1.1.62). Cato (*Agr.* 54.1-2) mentions feeding cattle soaked beech-mast or acorns, and the dregs from wine pressing during the off-season, and evergreen foliage as a last resort. Aelian (*NA* 17.30) notes that fish was also used as fodder for cattle in some areas. In addition, salt would have to be provided. Cattle are housed in winter and let out again in spring (Calp. *Ecl.* 5.103). Dangerous cattle were distinguished by the hay they carried on their horns (Hor. *Sat.* 1.4.34).

Farmers were expected to keep control over their herds no matter where the animals were. One law from the XII Tables (*Tablua* VIII, 8) states that cattle which trespassed onto the pasture of another farmer became the property of that other farmer. In a similar manner, a herdsman or farmer was obliged to compensate other individuals if one of his animals caused any loss or committed any damage against another farmer or his property (Ulp. *Dig.* 9.1.1-5; *Dig.* 9.2.2). Cattle rustling appears to have been a problem in antiquity. The Justinian Code outlines the strict and often vicious penalties paid by guilty cattle thieves (Jul. *Dig.* 13.1.14; Ulp. *Dig.* 47.2.10).

Integration

Available zooarchaeological and textual data about cattle in Roman Italy show much correlation, particularly in the topics of relative frequency, age, sex, and size. The texts mention that few cattle were kept at Roman farms; their chief purpose there was to pull the plough. The zooarchaeological evidence confirms this, with cattle registering around 10% of the total mammalian NISP and MNI figures amongst most rural sites. Sites in northern Italy record far more cattle than their southern and central Italy counterparts, with NISP and MNI frequencies hovering between 20-40% of the total; however, this is expected in light of the frequent textual references to northern breeds of cattle such as the Alpine and Ligurian, as well as the mention of the pasturing convenience provided by well-irrigated lowland valleys of which the Po River valley dominates in Italy. The lush fields and forests of northern Italy also provided the necessary grazing land, fodder, and shade vital to pasturing cattle.[33] A couple of other areas with quality pasture are mentioned in the texts. Virgil's (*G.* 2.195-202) praise of the territory around Tarentum in southern Italy is supported by the predominance of cattle remains at Metaponto (which is located in this area), compared to other regions in the south. However, the claims of Pliny the Younger

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[33] In addition, Tacitus (*Germania* 5) notes that neighbouring Germany is well provided with livestock, especially cattle. He further comments that cattle are the only form of wealth the Germans have, and thus are much prized. It is probable that this attitude extended into parts of northern Italy as well.

(*Ep.* 2.17) and Propertius (4.9.14) that the land just outside of Rome provided excellent pasturage for cattle are not unambiguously confirmed by the zooarchaeological data. Rural sites in this area, notably Via Gabina, Settefinestre, Lugnano, and Monte Gelato (although the latter three are further removed from Rome than Via Gabina) contain relatively few cattle remains and seem geared towards other agricultural and economic pursuits rather than cattle raising.

The texts refer to the importance of Apennine cattle in central Italy which is complemented by the zooarchaeological data. The sites located in this area—Narce, Luni, San Potito, Campochiaro, Saepinum, and Matrice (1st AD)—consistently record amongst the highest NISP and MNI cattle frequencies for all sites in central Italy. Urban sites located near Rome or in the Bay of Naples area register relatively fewer cattle remains than their inland, montane contemporaries.

The texts provide practically no details about temporal change in cattle numbers. There is no information for central and northern Italy, but one inscription from Lucania, in southern Italy, dating to 132 BC (*CIL* 1.2.638) notes how the Gracchan Law of 133 BC caused cattle-breeders to retire and be replaced with grain farmers (at least in the area of Lucania where this inscription derives). Zooarchaeological evidence supports this observation. NISP and MNI figures for cattle at most of the Republican period sites in southern Italy are well above their Imperial and Late Antique equivalents. Cattle may have been initially important in opening up land for cultivation in the south to feed the growing population. However, as population levels stabilized or declined later in time, and new demands were placed on southern Italy for products other than grain, the need for cattle decreased. A similar argument can be made for sites in central Italy, although here the drop in cattle frequencies over time is not as dramatic as in southern Italy, and there is much more individual variation. Cattle figures in northern Italy fluctuate markedly but overall show no great increase or decrease over time; cattle-raising remains relatively important throughout all temporal periods here.

Comparing the withers height data with the casual comments made about cattle size from the ancient texts is limited, but in general the two sources agree. The texts provide no details about size variation over time, but authors do stress the need to select only the best individuals for breeding. If the best individuals are repeatedly the largest cattle, then generations of breeding would certainly see an increase in the average size. The zooarchaeological data confirm such a temporal enlargement, with only minor variations and exceptions. In terms of geographic areas, the texts indicate that Alpine and Ligurian cattle (i.e., northern Italian cattle) were comparatively small; Umbrian, Etrurian, and Latium cattle (i.e., central Italian cattle) were large and powerful; while Campanian cattle (i.e., south-central Italian cattle) were generally small. Although there is considerable variation in individual measurements of cattle bones both within and between separate geographic and temporal groups, average withers height estimates show northern cattle to be the smallest of all three geographic areas in Italy. This probably relates to the relative abundance of presumably smaller-sized dairy cattle kept in this region. Here it may have been more economical for herders to possess greater numbers of likely more docile smaller cows than larger and potentially more difficult oxen and bulls. Cattle from central Italy are from 2 to 10 cm taller at the shoulders, on average, than their northern equivalents. However, the zooarchaeological data do not support the textual comments that Campanian cattle are small. In fact, the available cattle bones from most of these sites in this region are amongst some of the largest in all of Roman Italy. Perhaps larger, sturdier cattle were bred in central and southern Italy so that they might make more powerful draught animals in these agricultural areas, while smaller cattle might suffice for similar duties in the north.

While improvements in breeding within a single breed is perhaps the best explanation for the progressive increase in cattle size over time, irrespective of geographic area, it is not the only interpretation. It is also possible that a new larger breed (or breeds?) was introduced during later periods. While this may in part be true, especially during Late Antiquity when some exceptionally large cattle measures are recorded (e.g., a metacarpal Bd value of 79 mm, compared to maximum values of 69 and 72 for Republican and Imperial groups respectively; see Figures 13 - 15), I suspect that the observed size increase was principally due to improved breeding within individual breeds of cattle. The fact the minimum withers height values for each time period are fairly close suggests that smaller cattle were still kept. In other words, the older original breeds were still being used even in Late Antiquity. There was never a full replacement with an apparently bigger and better breed of cattle in any region or during any time period.[34]

Several cultural motivation factors may have been behind the increase in cattle sizes during Roman times in Italy. First, this enlargement may have been related to an augmented market economy, wherein cattle breeders could see a greater return for bigger, more meatier animals. A second possibility is that the increase was the result of people keeping fewer animals (King 1978: 216). In this case, more energy might be invested in maintaining strong and healthy individuals. Finally, it is possible that more larger cattle were needed for traction and plough duties during later Roman times.

Estimating herd sizes on the basis of animal bone data is a difficult task given the limitations of zooarchaeological sampling and quantification. Most sites register only a few cattle by MNI calculations, which when averaged over the span of occupation often accounts for less than one individual per year - hardly a herd. Since cattle comprise a small proportion (i.e., less than 20%) of the total mammalian NISP and MNI figures at most sites, I assume that herds, or at least large herds, were not kept there. Rather, the low frequency of cattle remains at many rural sites, especially those in central Italy, suggests that farmers maintained just a couple or perhaps a few cattle on site. Presumably, these individuals were used as work animals. This accords with the statistics and duties for cattle on Roman farms as presented by the ancient authors. Sites with very high frequencies of cattle, however, better support the existence of cattle herding, even if the absolute numbers estimated by the bones fall grossly short of the written values of 100-120 cattle as indicated in the ancient texts. Thus, sites like Kaulonia and Metaponto in southern Italy; Luni, San Potito, and perhaps Le Colonne in central Italy; Colognola, Pozzuolo del Friuli, Stufels, Innichen, Invillino, and Altino in northern Italy, are better candidates for cattle-herding operations either at the site or in the area. Each had total NISP sample sizes greater than 300, a relatively large portion of which was identified as cattle. Although Varro (*Rust.* 2.5.18) states that 100-120 cattle per herd is reasonable, on the basis of zooarchaeological data I assume that most cattle herds associated with these sites were much smaller, possibly one-half to one-quarter that size, and that no large-scale cattle herding sites have been identified yet in the archaeological record for Italy. These smaller herds characteristic of the eleven sites mentioned above were probably kept as part of a mixed farming regime which incorporated aspects of both crop and animal husbandry. Moreover, when one considers the great time and monetary investment associated with cattle raising, and the problems such as rustling and feeding as outlined in the ancient texts, it makes sense that large-scale cattle herding be restricted to those places and people with appropriate resources and wealth. Again, northern Italy was better suited economically, financially, spatially, and environmentally for any larger-scale cattle-raising ventures, a fact exemplified in both the textual and zooarchaeological evidence. The economic basis for large-scale cattle raising, however, depended on many factors. Considering the aggregate demand for meat, which included beef, amongst urban centres throughout Italy, it is likely that some beef cattle were also herded in regions of central and southern Italy, even though available zooarchaeological data do not presently support this totally.

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[34] Zooarchaeological studies of cattle withers heights also show smaller cattle to persist over Roman times in both the provinces of Pannonia (Bökönyi 1974) and Britain (Thomas 1989).

The age profiles indicated by the zooarchaeological data correspond with figures given in the ancient texts. Both attest to keeping older cattle. Virgil (*G.* 3.61) and Varro (*Rust.* 2.1.13, 2.5.13) note that cows were not to breed until two years, but were better served at three or four, and could continue to ten years. Males were castrated either as young calves or as two year olds (Varro *Rust.* 2.5.17; Col. 6.26.1), with oxen beginning their training as work animals in their third year (Col. 6.2.1; Varro *Rust.* 1.20.1). Bulls were deemed their strongest at five years (Plin. *NH* 8.70.178), but could mate up to twelve years (Col. 6.24.1). Life-expectancies of Roman cattle were reported at around 15-20 years (Plin. *NH* 8.70.178). Zooarchaeological data show that the majority of cattle lived beyond three years of age, a large percentage of which was certainly older than five years. At rural sites in particular, the data reveal that less than 15% of the number of cattle kept were killed in their first two years of life. Most survived to maturity, if not beyond into older ages. Owing to the predominance of oxen over bull remains, it appears that castration was commonly practiced in Roman Italy. Moreover, it was certainly performed prior to maturity, since adult oxen are normally recognized in the animal bone data. However, beyond stating that castration occurred sometime prior to three years of age, the zooarchaeological data yield no information to confirm textual reports of when specifically in that period of time this took place.

Although the number of sites with information about the sex of cattle remains is limited, the data available accord to some degree with the references in the ancient texts. Oxen predominate at sites where only a few cattle were presumably kept—sites like San Giovanni-period 2, Via Gabina, Torcello—thereby suggesting that these were in fact plough or work animals, and few, if any cows were raised (or consumed) on site. Bulls are infrequently represented amongst all sites, and in small enough numbers to confirm claims in the ancient texts of bull:cow ratios of 1:15, 30, or 35 (cf., Varro *Rust.* 2.5.12, 2.5.18; Col. 2.24.3; Plin. *NH* 8.45). The relative frequency of oxen and cows in a single herd, however, requires closer examination. The texts do not specifically mention the ideal proportions of oxen to cows in cattle herds, but it is logical that few oxen be kept in dairying herds, or in areas where they could not also be employed as work animals, and even that duty could be supplanted in some cases by cows (Varro *Rust.* 1.20.4; Col. 2.3.1-2, 6.22.1), thus rendering oxen economically useless. In most cases, therefore, we might expect to see a preponderance of cows over oxen, perhaps close to that 1:15 ratio cited above, depending on circumstances. The zooarchaeological data, however, show the oxen:cow ratio to vary considerably amongst sites. Pozzuolo del Friuli and Innichen, for example, record oxen:cow ratios of about 1:4 and 1:3, respectively, while a fairly equal balance between these sexes is reported at Colognola, Stufels, and Altino. Information about cattle sex was unavailable from the other sites (i.e., Kaulonia, Metaponto, Luni, San Potito, Le Colonne) where herds of cattle may have been raised at, or in the vicinity of. While live herds may have been composed of many more cows than oxen and bulls, this is not reflected in their death rates and bone remains, which leads me to surmise that the ideal ratios proposed by the ancient agronomists were either not adhered to, or impossible to attain. Cattle herders and breeders at some sites attempted to skew the sex ratios in favour of females, but were restrained from reaching the ideal 1:15 ratio. To accomplish this, the herders would need to export the majority of male calves, for if they slaughtered them on site and disposed of the remains with the rest of the bone waste then sex ratios would reflect natural birth ratios (i.e., c. 50% males, 50% females). At other sites, males may have been kept to older ages as brood stock, in the case of bulls, or to groom as quality plough oxen, in the case of castrates. The fact that oxen:cow ratios are relatively small, if not equal, for all of the sites in Roman Italy where cattle herds were potentially kept, supports the hypothesis that dairying never evolved beyond a minimum level or at least never to the point where it eliminated other ventures such as the production of quality oxen.

Using a cow as a work animal around the farm would limit its capacity to produce milk. Columella (6.24.4) was aware of this, which is why he recommended cows calve every second year, to allow for sufficient rest and replenishment of milk supplies. However, the milk was principally intended for the calf, and not for human consumption. White (1970a: 286) suggests that the pre-eminence given to the description of oxen over cows (Col. 6.1.3, 20-21; Varro *Rust.* 2.5.7-8; Pallad. 4.2) coupled with the absence of information about the udder and mammary system in references to cows, confirms the opinion that cows were principally raised as work animals and not generally exploited for their milk.

While cattle dairying during Roman times was neither widespread nor grand, there is some evidence that it was conducted. As noted above, cows comprised the bulk of the cattle samples from a couple of sites in northern Italy (e.g., Pozzuolo del Friuli and Innichen). Correlation with the aging data reveals that these cows were chiefly older individuals, beyond three years of age. Thus, they were old enough to produce milk. Moreover, very few, if any younger calves were reported at these sites. Presumably, these were removed (perhaps exported to urban sites) in order to exploit the cow's supply of milk. The zooarchaeological data indicate that the larger urban centres in northern Italy, on the whole, contain relatively more calves than their rural and settlement (i.e., urban2) counterparts. Pozzuolo del Friuli and Innichen are located in, or near, the north Italian Alps. This fact, when coupled with the evidence from the few measurements taken on the cattle bones obtained at each site, all of which indicate smaller-sized cattle, lends support to the assumption that both sites principally, if not exclusively, maintained the Alpine breed of cattle. Columella (6.24.5) praises this breed for its capacity to produce an abundance of milk, and the zooarchaeological evidence tends to support his statement. He even recommends exporting cows from Altinum, in the Po Valley, to act as foster-mothers for low milk-yielding, working cows in other parts of Italy (Col. 6.24.5). Although cow's milk was never the primary milk source in Roman Italy (caprine milk held precedence), it was customary to import cows into the cheese-producing areas of the Po Valley from the Alpine regions (White 1970a: 206).

Seasonal patterns of breeding and culling cattle are difficult to decipher using solely the zooarchaeological evidence. Small sample sizes and insufficient or imprecise data prevent any accurate seasonal assessment. The texts generally advocate summer mating with spring birthing (Varro *Rust.* 2.1.19; Col. 6.24.1; Ov. *Fast.* 4.633), but also recommend staggering births throughout the year, especially in Alpine regions (Plin. *NH* 8.70.177). Strict seasonal schedules may not have been followed at farms where small herds were kept, and probably had no impact at farms concerned with the maintenance of the necessary plough oxen or working cattle. In these cases, adequate stall space and food supplies could be found to accommodate the few cattle kept, with individuals slaughtered, sold, or traded throughout the year as the farmer saw fit. For larger herds, however, an annual cull might be expected (cf. Varro *Rust.* 2.5.17; Col. 6.22.1), considering that cows are pregnant for the better part of a year (i.e., ten months), with births normally timed for the spring (Varro *Rust.* 2.1.19). Columella (6.24.1) claims that spring births ideally coincided with fully grown fodder crops, and thus ample supplies of food for the young calves and their mothers. Moreover, since the animals could be kept outdoors from at least late spring through early autumn (Col. 6.3.1), accommodation problems such as finding enough stall space for the herd and its young would be reduced. Young calves could be fattened over the summer months on forage and fodder, with an annual slaughter taking place in the autumn or early winter months, when food supplies began to diminish, and farmers were advised to begin to collect fodder (Cato *Agr.* 6.30. 30.1; Varro *Rust.* 2.5.14; Calp. *Ecl.* 5.98; Plaut. *Most.* 1.1.62). Farmers would certainly have to trim the herd at this time in accordance with the number of stalls available for winter housing (Calp. *Ecl.* 5.103), and with predictions about the amount of stored fodder for the winter months.[35]

Maintaining cattle, even just a single ox, is an expensive task. White (1970a: 273) notes that at least twelve *iugera* would be required to support a team of two oxen, while Jongman (1988: 153) states that one ox in southern Italy needs about ten to twelve hectares of rough grazing.[36] This puts an incredible strain on any small-scale farmer with limited land holdings, the difficulties of which are discussed elsewhere (Braudel 1981; Brunt 1971; Delano-Smith 1979; Frayn 1984; Foxhall 1990; Jongman 1988; Lirb 1993). The basic premise is that humans and animals compete for food. In the case of oxen, therefore, a peasant farmer would have to weigh the factors associated with providing sufficient fodder to keep his own team of oxen, against the need to feed himself and his family with the resources from his land.[37] This is generally known as "the food-or-feed dilemma" (Lirb 1993: 290-291).

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[35] Clark (1992a: 57) notes that more cattle were killed in the early summer and winter during late Medieval times in Italy, on the basis on early 15th century documents from Bologna and near Lucca. This might coincide with summer and winter fodder shortages, which would be an ideal time to cull the cattle herd.

[36] These figures would vary depending on the productivity of the land and the degree to which farmers integrated animals into their agricultural systems. Grazing livestock on stubble, gleanings, aftermaths and fallows are several ways animals could be integrated into the agricultural schemes and have less impact on the amount of area required for pasture. Leguminous fodder crops are another method. These would provide feed for the animals, but also replenish nutrients in the soil. Other integrating practices include letting animals graze on cropped fields to reduce excess vegetative growth in the early stages, feeding them residues of the harvest and processing of main crops (straw, chaff, mast dregs, grape dregs, etc.) as well as

Several options are available to the small-scale farmer to cope with this food-or-feed dilemma. First, he could use other animals, with smaller appetites than an ox, to pull the plough. According to Varro (*Rust.* 1.20.4) cows can be used to plow light soils. An average cow consumes less than an ox, and brings the benefit of milk. Cows are present at nearly every site dating to the Roman period in Italy where animal bones were recovered and sexed. Some could have been used to pull the plough, but given that the fact that in most cases these cows appear to co-exist with oxen, I would suspect that oxen chiefly assumed this duty. If cows were exclusively used as work animals, then there would have been no need to keep oxen.

Mules and donkeys might also replace cattle as work animals. Columella (7.1.1-2) notes that donkeys can survive and work even when they are fed little and inferior feed. In addition, a single donkey or mule can pull the plough; it does not have to be yoked to a partner as is the case with cattle. Several ancient reference attest to the use of donkeys and mules to draw the plough, but generally only on light soils such as in the Campanian region (Varro *Rust.* 1.20.4, 2.6.5; Col. 7.1.2; Plin. *NH* 8.167, 8.171, 18.3.41). More references, however, describe them as pack animals, presumably their chief function (Cato *Agr*. 10.1, 11.1; Col. 7.1.2; Varro *Rust.* 2.6.5, 2.8.5; Verg. *G.* 1.273; Hor. *Sat.* 1.6.103-106, 1.9.20-21; Ael. *NA* 7.42). Although equids lie outside of the scope of this thesis (i.e., they were not normally consumed), Tables 16 - 19 and Figures 8 and 10 show that their bones were commonly present at many rural sites in Roman Italy. Donkeys appear to outnumber mules (see Table 14), but these figures should be interpreted with caution since it is difficult to distinguish mules from donkeys and horses on the basis of osteological data alone (Armitage 1979; Eisenmann 1981). Lirb (1993: 292) notes that mules are more typical to small-scale agriculture than oxen (cf., Delille 1977: 135 n.87; Schneider and Schneider 1976: 127; contra., Carandini 1985: 124; Dohr 1965: 135).

A second option for coping with the food-or-feed dilemma is to share, rent, hire, or lease plough cattle. The ancient texts attest to all of these practices. In his discussion of partnership agreements in antiquity, Lirb (1993) suggests that the pooling of resources amongst ancient farmers was commonplace, regardless of the size of their land holdings, or the scale of their agricultural ventures. The high degree of property fragmentation through inheritance would have made sharing a necessity. Several partnerships or sharing

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providing prunings and leaves gathered from vines and trees. A number of references attest to these multiple dietary options for farm cattle (Cato *Agr*. 6.3, 30.1, 55.1; Varro *Rust*. 2.5.14; Col. 6.3.3; Calp. *Ecl.* 5.98; Plaut. *Most.* 1.1.62). Further discussion on systems of crop rotations involving leguminous plants and the integration of livestock into ancient agricultural systems can be found in Delano Smith (1979), Gallant (1991), Halstead (1987), Lirb (1993), Spurr (1986), and White (1970).

[37] Be this owned or rented land, the basic predicament is the same.

agreements involving agricultural service and materials, including plough oxen, are noted in the ancient texts (e.g., Cato *Agr.* 144.4-5, 145.3; Cic. *Quinct.* 12, 15, 23; Just. *Inst.* 3.24.2, specifically for plough oxen).

Plough oxen could also be hired or leased. While there are more textual references to hiring and leasing animals such as donkeys and mules for transport jobs,[38] several relate specifically to oxen, even though the context of plough or transport teams is not always made clear (Cato [*Agr.* 22.3] and Columella [2.7.6] both refer to the hiring out of cattle, *boves*, for unspecified work purposes, but likely transport). There certainly would have been inconveniences to leasing and sharing cattle. Demand would have been strongest during plowing times, which may have led to overworked oxen. However, the benefits, especially the reduced demand placed on individual farmers to maintain a yoke of oxen on very small holdings, surely outweighed these problems (Foxhall 1990: 107).[39]

Lastly, the overall good health of most of the cattle from Roman Italy accords with the emphasis the ancient texts place on proper animal care and maintenance. However, the relatively high frequency of pathological cattle bone examples compared to other animals, including equids,[40] attests to an elevated degree of age and work-related stress, possibly a factor of the demand for sharing and renting plough oxen, as mentioned above. Pathological conditions such as osteoarthritis, extoses formation, and eburnation on bones of the lower leg (i.e., metapodials and phalanges) predominate amongst skeletal abnormalities. Pulling the plough and drawing carts would place considerable stress on cattle legs, especially if they had to contend with uneven, rocky, and treacherous terrain. Curiously, there are no recorded pathological conditions on cattle vertebrae, ribs, or shoulder bones. The plough would certainly place extra strain on these elements, especially considering the relatively primitive and somewhat inefficient nature of the yoke. Broken ribs, and arthritic vertebrae and scapulae might be expected, but this is not confirmed in the zooarchaeological data. Ribs and vertebrae, however, are not always identified to species; therefore, there is the possibility that abnormalities amongst these elements have been overlooked.

Part 2: SHEEP AND GOATS

Zooarchaeological Data

Identification and Quantification

Sheep/goat bones were ubiquitous amongst rural sites and both types of urban sites, being present in 100% of the cases, while 80% of the special sites used in this analysis had sheep/goat bones in their deposits. Although there are some minor discrepancies between

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[38] Most of these are listed and discussed by Lirb (1993) and Martin (1990), and will not be considered here.

[39] Another option to cope with the food-or-feed dilemma is to integrate livestock more effectively into agricultural systems. See note 32 above.

[40] Equid pathological conditions are not reported here, but in general their frequency is much lower than that for cattle, especially when the relative incidence of arthritic phalanx bones is compared.

NISP and MNI figures, overall there is no dramatic variation between NISP and MNI patterns.

Figure 19 displays the calculated mean values of the various NISP and MNI frequencies for sheep/goat according to site type, while Table 29 lists the range, variance, standard deviation, and sample size for these. Only sites with total NISP and total MNI values of 100 and 10, respectively, have been used in these calculations.

The overall difference between sets of NISP and MNI values, as shown in Table 29 and Figure 19, is slightly more than that given for cattle (see Table 20 and Figure 11), but not overwhelmingly so. In most cases, the average NISP and MNI frequencies are within eight percentage points of one another, with the exception of special sites which record nearly a ten point spread. Sheep/goat average NISP and MNI frequencies for rural and urban1 sites are generally quite close. Each registers between about 25% to about 35% of the total mammalian NISP and MNI figures. Urban2 sites contain the greatest frequency of sheep/goat bones by both NISP and MNI calculations. Special sites generally record low values for sheep/goat, especially on the basis of NISP comparisons.

Figure 20 shows the mean relative frequency of sheep/goat remains calculated on the basis of NISP and MNI values, but with the data broken down into similar geographic region, time period, and site-type clusters. Special sites are not included in Figure 20. Only sites with total mammalian NISP and total mammalian MNI values of greater than 100 and 10, respectively, have been included.

There are a few major discrepancies between NISP and MNI frequencies, as shown in Figure 20, specifically at S/1/r, C/1/u1, C/1/u2, and N/2,3/u2, but overall there is less than a 10% difference between sets of NISP and MNI statistics. In some cases the values are very close (e.g., C/2/r, C/3/r).

The data in Figure 20 indicate that sheep and goats were most prominent during early time periods, at least in central and southern Italy. A reverse pattern is displayed for northern Italy with sheep/goat here increasing in abundance from Republican to Imperial times, but not necessarily into Late Antiquity as well.

Both NISP and MNI mean frequencies for sheep/goat drop substantially for rural sites in south Italy from earlier periods to later periods. In fact, rural sites in southern Italy show the greatest change in these values, with a decline from Republican to Late Antique times of c. 30% and c. 15% on the basis of NISP and MNI statistics respectively.

The sheep/goat pattern amongst sites in central Italy generally shows fewer dramatic fluctuations compared to south Italy. The frequency declines from the Republican to the Imperial period, but thereafter remains fairly stable at c. 25% of the total mammalian NISP and MNI values. Moreover, there is little difference between the sheep/goat frequency values amongst rural and urban sites in central Italy at this time.

Sheep/goat frequencies in northern Italy follow a reverse pattern than that shown elsewhere in Italy. Their values increase from Period 1 to 2, then tend to decrease from Period 2 to 3. With the exception of N/2,3/u2, however, the relative frequencies for sheep/goat in northern Italy is very similar to that for Imperial and Late Antique central and southern Italy (i.e., NISP and MNI mean frequencies of c. 25%).

Sheep/Goat Distinction

Table 30 lists the number and frequency of sheep and goat bones for individual sites. The sites are arranged according to region, period, and site type. In some cases, NISP values were not given, but frequencies (or approximations) still recorded. The data indicate several points. First, there are many sites for which no distinction was made between sheep and goats. Just over half of the total number of sites (or parts thereof) which recorded sheep/goat in their NISP tallies (see Table 16) provide information about the relative frequency of either species, as displayed in Table 30. Second, there is great variation in sample sizes, with the majority of sites registering less than ten bones which could be identified as sheep or goat. Despite the small sample sizes, however, the data show fairly consistently that sheep predominate over goats. There are generally three to six sheep bones identified for every goat bone, depending on the site. The only site of substantial sample size where goats outnumber sheep is Locri.

Table 31 summarizes the frequency data in Table 30 according to site type. Only sites with sample sizes greater than ten have been included. "Special" sites are excluded. Although sheep outnumber goats at all of these site types, the data indicate that they are slightly more prevalent amongst rural sites than either type of urban site. On average, there are slightly over six sheep to every goat at rural sites, while only about four sheep to every goat amongst urban1 and urban2 sites. The data further show a much broader range in sheep and goat frequency values amongst urban sites than rural sites. The percentage of sheep at urban sites ranges from a somewhat low 55.6% to just over 95%, while the comparable range for rural sites is 72.7% to 100%.

Table 32 lists the range and mean frequencies of sheep/goat according to geographic area. Only sites with samples sizes greater than 10 have been used. Sites types have been combined, but "special" sites are not included. The data support previous analyses in that sheep predominate over goats in all geographic areas. However, sheep are not equally numerous. They are most prevalent in the south and least common amongst sites in central Italy. The average ratios give values of one goat to every 5.7, 3.4, and 4.3 sheep, for southern, central, and northern Italy respectively.

Finally, Table 33 provides the range and average frequency values for sheep and goat according to temporal period. Only sites with sample sizes greater than ten have been included in these calculations; special sites have been excluded. Again, these data support all prior analyses. Sheep largely outnumber goats during every period. They are most numerous during Period 1 and least frequent during Period 2; however, some caution is required in interpreting these results. The vast majority of Period 1 sites are located in southern Italy, which, as shown in Table 32, has the greatest sheep to goat ratio of all regions. Period 1 sites, therefore, are predisposed to have more sheep. Furthermore, all of the Period 2 sites used in Table 33 derive from northern Italy. There is no balance between geographic area and temporal period, and consequently a certain bias exists in comparing these factors.

Age

Table 34 gives a summary of the fusion data for sheep/goat; the complete data are listed in Appendix 6. The data in Table 34 are arranged according to site type. Only sites with fusion samples sizes of greater than ten are included in Table 34. Values indicate the mean frequency of bones with unfused epiphyses. Thus, "30.7" in the 12 months category means that 30.7% of the bones with epiphyses that fused at approximately 12 months had unfused epiphyses, or in other words, 30.7% of sheep/goat were younger than one year.

Table 35 presents the mean frequency and range of sheep/goat at various ages calculated on the basis of dental data. The complete list of all individual sites including information on which method(s) for dental aging was used is given in Appendix 7.

Finally, Appendix 8 provides comments made by researchers about the relative frequency of sheep/goat bones at various age stages such as juvenile, subadult, adult, old age, etc. In some cases numeric percentages are given, while in other cases this is expressed as some relative term (e.g., "many," "most," "few," etc.).

Although the sample sizes for sheep/goat are larger than those for cattle, they are still somewhat small; therefore, the patterns exhibited must be interpreted with caution. Moreover, there is greater chronological ambiguity in epiphyseal fusion amongst sheep and goat bones than with cattle bones. A larger bracket of ages, spanning 14-36 months, is noted for sheep/goat, but this is divided into two groups for cattle (i.e., 12-18 months, and 24-36 months). Thus, the fusion data allow for enhanced separation of cattle between one and three years of age, but not correspondingly for sheep/goat. The dental age groups, however, do separate ages within this broad 14-36 month span, and may be used to determine the frequency of animals killed between 12-24 months and between 24-36 months of age.

It should always be remembered that Tables 34 and 35 present the mean values from a number of sites where individual statistics can vary considerably. A review of Appendices 6 and 7 highlights this fact. The spread between minimum and maximum values amongst site types is often more than 50%. In the dental data particularly, some sites register no individuals at all within certain age groups, while other sites, despite being of the same type, record some or perhaps even many within that same age group. There is clearly much individual variation in the frequency of sheep/goat amongst sites from Roman Italy, which is hidden to a certain degree in any general comparative analysis.

With these caveats in mind, the data in Tables 34 and 35, and Appendices 6 - 8, indicate that very few sheep and goats survived to elderly ages, regardless of site. According to the fusion data, on average c. 40% of the sheep and goats amongst rural and urban sites lived beyond 48-60 months. The dental data, however, suggest a smaller percentage (c. 15%-20%) actually survived beyond 48 months of age.

Fusion and dental data agree in the case of sheep and goat deaths under 12 months of age at rural and urban1 sites. Approximately 30% of the bones which fuse within the first year of a sheep or goat's life had unfused epiphyses, while the sum of the three individual dental age categories for the same period (i.e., 0-2 months, 3-6 months, and 7-12 months) gives a value of c. 30% as well. The corresponding urban1 fusion and dental values at c. 24% and c. 20%, respectively, are relatively close. The values for urban2 sites, however, do not agree. Fusion data indicate c. 3% of sheep/goat were under 12 months at urban2 sites, which conflicts with dental results of c. 30% for the same age bracket.

According to the dental data, c. 54% of the sheep/goat at rural sites, and c. 60% of them at urban1 and urban2 sites were killed between 12 and 48 months of age. The corresponding fusion data, however, tend to support reduced figures for sheep/goat deaths under 48 months of age. This is especially true in the case of urban1 sites where frequencies show that just under one-half of the total number of sheep/goat deaths occurred prior to 48 months of age (and this value is for 0-48 months, and not just 12-48 months, which makes it even more notable since it potentially includes deaths within the first year of life, which have not been used in the dental value). There is clearly much discrepancy between fusion and dental data within these middle-age categories.

Little can be said about the sheep/goat age patterns at special sites. No site provided fusion data, while only three sites supplied dental data. The available evidence indicates a mix of sheep/goat ages which is very much contingent on the context.

Age patterns amongst sites with sample sizes of less than 10 generally conform to those shown above. There is a mix of all age groups amongst rural and urban sites, with a fair percentage of sheep/goat surviving to older ages, but most were still killed between 12-60 months. Adult sheep/goat predominate amongst rural and urban2 sites especially, with subadults and juveniles best represented amongst urban1 sites, although still never exceeding 40% of the total. A mix of ages is also displayed amongst special sites. Young lambs and kids, less than 14-36 months, comprise the majority at a few of these, notably some of the "bothros" deposits of southern Italy, but there are exceptions as well.

Seasonality

Little seasonal information can be gleaned from the sheep/goat aging data. As in the case of cattle, most of the sheep/goat age categories used in the dental analysis each encompass one year, and as such tell us nothing about when within that year any seasonal concentration of deaths may have occurred. However, since the first year is divided into three separate age group—0-2 months, 3-6 months, and 7-12 months—a comparison of the relative frequencies within each category can give an idea about seasonal culling. For example, a preponderance of deaths in the 3-6 month category, with few deaths in the other two age brackets indicates a seasonal cull around 3-6 months after birthing. If sheep and goats are known to mate in late spring and give birth in late autumn, then a 3-6 month peak in deaths would point towards a late-winter/early-spring cull.

The data from Table 35 show some variation in the frequency of deaths within the 0-2 month, 3-6 month, and 7-12 month categories, on the basis of site type. Rural sites register slightly more deaths in the 3-6 month group than in the 7-12 month group, which supports the hypothesis of enhanced late-winter/early-spring cull at Roman farms (again assuming autumn births). At urban1 and urban2 sites, however, the pattern is reversed, with 7-12 month deaths outnumbering 3-6 month deaths. This suggests a preference for an annual cull in the summer/autumn time, rather than during winter/spring. While urban sites are less likely to practice shepherding themselves, and thus tell us directly about such activities, they appear to have been supplied with caprines that were killed predominantly in the summer/autumn months, or 7-12 months after birth.

Although some minor patterning in terms of seasonal culling is shown in Table 35, the differences amongst the data values are generally too small to allow any firm conclusions. The case for seasonal slaughter is strengthened, however, when values for the individual sites (Appendix 7) are examined. A few sites register more than 20% of the total number of sheep/goat deaths within the 3-6 month category. These are Gravina (pit), Matrice-period 2, Stufels-Senoner, Innichen, and Monte Barro. All of these are either rural or urban2 sites. The preponderance of 3-6 month lambs/kids in these deposits may indicate that a late-winter/early-spring cull was practiced at these sites, assuming autumn births. An argument for an annual late-winter/early-spring cull in these cases would be strengthened by a relative lack of deaths in the 7-12 month category, since this would span the remainder of the year. Although all five of the sites listed above fulfill this criterion to some degree, it is best shown at Gravina (pit), Matrice-period 2, Stufels-Senoner, and Innichen.

The fact that some sites in Appendix 7 register relatively more 7-12 month sheep/goat deaths than either 0-2 month or 3-6 month deaths suggests summer/autumn culling (assuming autumn births). Sites such as Colognola, Invillino, Cozzo Presepe, and San Giovanni-period 2 all fall within this pattern, while urban centres such as Pompeii-Ganimede, Populonia, and Modena seemed to have been supplied with sheep and goats killed predominantly in the summer/autumn as well.

Sex

Table 36 lists the number of sheep/goat bones for which sex was determined and the frequency of males, castrates, and females from those counts. Few sites reported any information about the sex of sheep and goats. There are only a handful of caprine bones with dimorphic features of value to the zooarchaeologist. These include the skull and horn core, axis and atlas, pelvis, and astragalus (Böessneck 1969; Böessneck et al. 1964; Prummel and Frisch 1986). However, each of these dimorphic indicators is not always reliable, considering the amount of variation and overlap exhibited in some samples, which is probably part of the reason some are infrequently applied. The skull, pelvis, and astragalus appear to show several of the more readily ascertained dimorphic characteristics, but tests for all have produced inconsistent results. Furthermore, it is difficult to distinguish castrates. Hatting (1975, 1983) noted changes in sheep horn cores as a result of castration, but the method is troublesome to apply and demands accurate age determination. Only three sites (Colognola, Innichen, and Stufels-Hotel) provided a count for castrates.

Although caprine sex sample sizes are small in many cases and the number of sites much reduced compared to the grand total of sites with zooarchaeological data, several points can be made. First, while most reports were not explicit about the proportions of sheep or goats that were part of their sex determination, in light of the fact that sheep outnumber goats (see Table 30), I assume that the majority of the sheep/goat bones sexed above belong to sheep, and that the results to follow apply more to these animals. Second, available data indicate that female sheep/goat generally, and often times significantly, outnumber males. If we exclude those sites with a sample size of less than three, then female sheep/goat predominate at every rural site and nearly every urban site. Even when males outnumber females (e.g., Pompeii-Ganimede and Stufels-Hotel), the difference is still very slight (c. 60% males: 40% females). A third point is that female sheep/goat appear to be more prevalent amongst Period 1 sites in southern Italy (e.g., Gravina, Cozzo Presepe), while relatively more males and castrates are reported from Period 2 and 3 sites in the north (e.g., Stufels, Innichen, Invillino, Colognola). There are insufficient data to draw comparisons with central Italy.

Age and Sex Correlation

The same complications that hinder correlation between age and sex of cattle remains apply to sheep/goat bones. Generally, the age and sex are defined using different bones of the skeleton. Sex is often determined using morphometric characteristics of fused bones, and therefore is more easily correlated with adult animals (i.e., in this case, sheep/goat in dental categories of 3+ years). In the absence of data on the sex of younger bones, I have made the following assumptions. First, I assume that those sites with fairly equal male to female sex ratios retained this balance for all age categories. An imbalance in the sexes at earlier ages would upset the balance at later ages, although it is possible that a quantity of males be killed at one age, say six months, with equal numbers of females killed slightly later, at around one year, which would still produce a balanced sex ratio in the subsequent adult population. Second, I assume that those sites with more adult males or females achieved such a state by killing more younger animals of the opposite sex. Thus, a preponderance of adult females implies selective slaughter of younger males, which, owing to the problems of sexing immature bones, goes unnoticed in the zooarchaeological record.

Table 37 attempts to combine the information on sheep/goat age and sex. Four broad categories are recognized: young males, older males, young females, and older females. The relative frequency of each category is denoted by a range of "•," with no "•" (i.e., blank space in column) meaning total absence, and "••••" indicating a great abundance. For those sites without dental aging data, fusion data were used instead. These cases are noted in the "sample size aging" column.

Only 17 sites in Table 37 provided both sexing and aging information for sheep/goat; most of these are situated in either southern or northern Italy. Moreover, sample sizes, particularly those for sexing, surpass ten in just seven of these cases, none of which is located in central Italy. Available data from Table 37 show that older female sheep predominated amongst most sites in southern Italy, thereby suggesting an economy based on secondary products, such as milk and wool, as well as herd reproduction was practiced in this area. The preponderance of young individuals in the Gravina-pit deposit probably relates more to an elitist diet than to a specialized economy geared towards massive slaughtering of lambs and kids. The situation in northern Italy is slightly different. Although adult females still tend to dominate, the data register a greater balance between age groups and sexes. Thus, the herd profile indicates an economy where meat, wool, milk and other products were exploited with relatively equal importance.

Size

Table 38 provides the withers height range, mean, variance, standard deviation, and sample size and composition for sheep/goat. Withers heights were calculated using Teichert's (1975) factors. Sites are grouped according to region and time period. The sheep/goat sample sizes are considerably larger than their cattle counterparts. Much of this is due to the inclusion of the astragalus and calcaneum, which do not have corresponding withers height factors in the case of cattle. While it certainly helps elevate sample sizes, the inclusion of the astragalus causes some problems. The astragalus is a single solid bone, without epiphyses, which grows with maturity; thus, it is difficult to judge to what degree the variation in its size is a factor of unrecognized age differences amongst specimens. This is not a concern for bones with epiphyses, where fusion, generally at a fixed age interval, arrests growth in bone length. In order to test for potential bias, I have included a column in Table 38 which lists the mean withers height for sheep/goat as calculated without the astragali measurements. Although the difference between corresponding means varies depending on which group is considered (e.g., S-1 has a 3 cm difference, N-2/3 only a 0.1 cm difference), the overall means lie a close 0.7 cm apart. Most importantly, the exclusion of the astragalus does not change the patterning within each regional group, or significantly upset the ordinal ranking of the values from highest to lowest. The only change in the latter is a displacement of S-1 from 6th to 8th highest mean. On the basis of this evidence I assume that the inclusion of the astragalus has not noticeably altered results, therefore I will refer to the values in Table 38 which include the astragalus for the rest of this analysis.

With only a couple of exceptions, the data in Table 38 indicate that the average size of sheep/goat increased through Roman times. This rise is slight, but consistent in southern Italy, where the data show a progressive withers height increase from 66.4 cm (Republican period) to 66.8 cm (Imperial period) to 67.0 cm (Late Antiquity). Central and northern Italy record a much larger jump from Republican to Imperial times—an increase of 4 cm apiece in the average withers height. However, the data are mixed in terms of the transition from the Imperial period to Late Antiquity in these regions. The maximum withers height for sheep/goat in Late Antique central and northern Italy is substantially higher than its Imperial period counterparts (i.e., compare 79.4 cm and 88.9 cm with 74.1 cm and 77.1 cm), but in both cases the mean values decline over the same interval (i.e., central Italy—69.8 cm to 69.1 cm; northern Italy—68.3 cm to 64.8 cm).

Again the great span in ranges and fairly high variance and standard deviation values attest to the presence of different breeds of sheep and goats in each region and during every time period. The difference between maximum and minimum withers heights statistics is over 35 cm overall, with individual region-time period groups recording differences of 8.8 cm (C-2) to 31.3 cm (N-2/3). The greater ranges are difficult to justify on the basis of nutritional, health, and sexual variation alone. Genetics and breeding variation were likely components. Considering that the data from S-2, S-3, and N-1 all derive from single sites (i.e., S-2 and S-3 all from San Giovanni, N-1 from Colognola), it is not surprising that the concomitant ranges for S-2, S-3, and N-1 are amongst the smallest of those for all groups. Such a pattern lends support to the hypothesis that individual sites kept only single breeds of both sheep and goats - certainly no more than a couple. Consequently, the size range amongst individual members of the flock was somewhat restricted.

Abnormalities

Table 39 lists the incidence of various categories of skeletal pathological conditions for those Roman period sites in Italy which provided such information. Table 40 provides a similar count for dental elements exclusively. Sites are arranged according to region, time period and site type.

There are many more examples of skeletal abnormalities in sheep/goat compared to cattle (see Tables 27 and 28). Again, sites in central, and to some degree southern, Italy claim more pathological bones than those in the north. Moreover, the data from Tables 39 and 40 show a majority of skeletal abnormalities during Late Antiquity than during other periods. Dental pathological disorders figure prominently, which is not surprising considering sheep/goat teeth were common finds at most sites. No incidence of dental caries, or cavities, was reported for any site; thus it is not given in Table 40. Calculus (i.e., tartar) deposits, however, frequently occur. Periodontal disease, tooth infection, and abcess development also rank amongst the more widespread dental ailments. There is often a link between all these pathologies, so it not unusual for them to correlate. Calculus build-up can cause irritation and initiate or enhance other dental pathological conditions such as periodontal disease or abcess development. Crowding and twisting of teeth, as well as ante-mortem tooth loss can lead to abnormal wear. Although not as prevalent as calculus and associated pathological conditions, such ailments, and especially dental crowding, often help indicate domestication, while tooth loss and abnormal wear inform us about the survival of individual animals under handicapped, and often very painful conditions.

In terms of non-dental pathological conditions, the data from Table 40 reveal little. Osteoarthritis is the most common non-dental abnormality. Sheep and goats developed osteoarthritis generally in their phalanges, and again such a condition would likely intensify (and be more recognizable) the older the animal lived. Traumatic injuries and infection occur with less frequency; a couple of cases, such as a fractured and healed tibia and femur are noted.

Textual Data

Sheep

Sheep were an important resource in Roman Italy and there are many references to them in the classical texts. They were primarily raised for their renewable secondary resources, principally wool, but also for milk and for cheese. Their meat was also eaten, including meat from sacrificed lambs. Sheep-raising was widely distributed in Italy, and the schemes used were perhaps the most variable of those for all animals; they ranged from nomadism, to free range and transhumance, to folding and stall feeding. Although the Roman authors generally distinguish two broad systems of sheep husbandry (i.e., folding at the farm and transhumant herding) each is not always clearly demarcated, and elements of these apparently separate systems sometimes overlap with their counterpart.

Sheep were common animals on most Roman farms. According to Varro (*Rust.* 1.19.3), some sheep should be kept around the farm in order to provide constant supplies of manure for the meadows (Alf. *Dig.* 32.60.3). Cato (*Agr.* 10.1) recommends a flock of 100 for an olive farm of 240 *iugera*, but does not include them in a vineyard of 100 *iugera* (Cato *Agr.* 11.1), since they could not suitably graze among vines. Depending on the environmental conditions, these flocks could be let out to browse on pasture lands close to the farm during the day and folded in courtyards, or even stalls, at the farm during the night. Calpurnius (*Ecl.* 1.38-41) alludes to the use of sheep pens during earlier times; other authors provide more details. Sheepfolds should be placed in a suitable area, protected from the wind and facing the east rather than the south (Varro *Rust.* 2.2.7). They should be built low and extended in length rather than width so that they may be warm in winter and also that lack of space may not cause the ewes to cast their young (Col. 7.3.8). A closed court with a high wall should be constructed in the front of the entrance so that the sheep can leave their stall if they get too hot (Col. 7.3.8). Furthermore, separate enclosures should be built at the farm so that pregnant ewes and sick individuals may be removed from the flock (Varro *Rust.* 2.2.8). Cato (*Agr.* 39.1) and Varro (*Rust.* 2.2.7) caution to keep all sheepfolds clean to avoid the spread of disease.

Transhumance, or seasonal movement of sheep and goats, is also referenced in the ancient texts. The ancient authors offer some information, most of which is found in Varro's treatise. He hints at seasonal movement of the flock in Book 1 when he notes that summer pastures in mountain districts (examples include the area around Samnium [Varro *Rust.* 2.1.16-17], the Reatine hills [Varro *Rust.* 2.2.9-10] and the Sabine hills [Varro *Rust.* 2.2.9, 3.17.9]) offer abundant forage while those in lowland plains are fresh and lush during the winter months (Varro *Rust.* 1.6.5). Later he discusses his flock which traversed from the Samnite hills, in central Italy, to the coastal plain around Heraclea, in southern Italy (Varro *Rust.* 2.1.16, 3.17.9), and he notes the movement of a friend's flock which journeyed from Umbria to pastures near Metapontum, again in southern Italy (Varro *Rust.* 2.9.6). One motive behind this move may have been to sell wool or other animal products at the market in Heraclea (Varro *Rust.* 2.9.6), although some members of the flock doubtless had to trek back to their upland summer pastures if this annual process was to continue. Horace (*Carm.* 2.15.14) provides further seasonal information about transhumance when he states that the sheep change their lowland Calabrian (i.e., Salentine) pastures for the interior and more hilly Lucanian ones when the "dog star appears" (i.e., in the summer).

Transhumant herds were large in comparison to farm herds. Varro had a flock of about 700, and he records figures for some other flocks: 800 for that of Atticus, and over 1000 for some others (Varro *Rust.* 2.10.11). Pliny the Younger (*Ep.* 2.17) writes of his "numberless flocks of sheep...which the severity of winter has driven from the mountains (to) fatten in the vernal warmth of this rich pasturage (around Rome)," while Martial (7.80) refers to flocks of sheep tended at Tivoli, just outside of Rome.

Transhumant journeys might be long and arduous. Varro (*Rust.* 2.10.3) recommends hiring strong herdsmen who can endure the hardships of the mountains. One herdsman per 80-100 sheep was standard, although that ratio could vary depending on the owner (Varro *Rust.* 2.10.10-11). In addition, extra sheep dogs might be required depending on the distance traveled and the dangers involved, the latter referring specifically to wild beasts residing in mountain woodlands (Varro *Rust.* 2.9.16).

More details connected with long-distance transhumance derive from inscriptional evidence. Perhaps the most famous instance, the Saepinum inscription (*CIL* 9.2438 =*FIRA* 1.61; Corbier 1983), which still stands on the outer wall of the north gate of Saepinum, about four metres above the *tratturo*, or drove road, which passes through the gate, documents correspondence concerning the maltreatment of contracted shepherds in the region of Saepinum and Bovianum, during the reign of Marcus Aurelius (Corbier 1983). The nature of the conflict, which involves several orders of local and imperial governmental officials and intermediaries, not only proves the existence of long-distance movement of flocks, at least in parts of Roman Italy, but also documents its regulation by the state (Corbier 1983: 131). Two further examples provide more evidence for governmental involvement in pastoralism. Varro (*Rust.* 2.1.16-17) notes that transhumant herds are to be reported to tax-collectors for fear of offending against censorial regulation forbidding the pasturing of unregistered flocks, while the Agrarian Law of 111 BC states that no charges shall be laid upon animals which feed along the edges of public roads when being herded to their destination (R109 = *FIRA* 8.26 = *ARS* 51.20; Buck 1983). Similar legislation can be found in an inscription found near Genoa (*CIL* 1.2.584).

Several other inscriptions help document the existence of long-distance transhumant pastoralism in Roman Italy. Two of these—one, a dedication stone by a senatorial class woman, Nummia Varra to a freedwoman, found in Canosa, southern Italy (*ERC* 165; Roe 1992); the other an inscription honouring, most likely, the same Nummia, but found in Abruzzi (*CIL* 9.3429, 3436; Roe 1992)—suggest a link between two areas of Italy, likely created from transhumant herding of sheep and goats (Grelle 1981: 220). Other examples (*ERC* 78 and *CIL* 9.3113; Roe 1992) note the presence of various individuals probably associated with the economics of pastoralism.

Pens are mentioned to contain these flocks at the lowland farms during the winter and early spring (Col. 7.3.25; Calp. 5.103, 7.9; Sid. Apoll. *Carm.* 7.364-368, Sid Apoll. *Epist.* 1.4.part 4; Ael. *NA* 9.31, 16.26; Hor. *Odes* 1.4.3-4; Virgil *G.* 3.295-296). Horace (*Epod.* 2.45-46) speaks of "wattled folds," while Calpurnius (*Ecl.* 5.116-118), Virgil (*G.* 3.296-297) and Varro (*Rust.* 2.2.7) add that stubble needs to be strewn on their surfaces as bedding, and to deter the spread of scab and foot-rot. Virgil (*G.* 3.302-304) mentions that these sheep stalls should front south to catch the most sun, but Varro (*Rust.* 2.2.7) recommends that sheepfolds face the east rather than the south. Flocks were not to be let out of these sheepfolds until late spring, after appropriate sacrifices had been made (Calp. 5.24-28, 103; Verg. *G.* 3.296). Ovid (*Fast.* 4.735-748) describes the processes and sacrifices involved in fumigating and purifying the sheepfolds. Temporary pens or shelters would have assisted in grouping and protecting large transhumant flocks at upland pastures during the summer (Calp. *Ecl.* 5.63-65). Varro (*Rust.* 2.2.9) states that shepherds should carry hurdles or nets with which to make enclosures for their flocks in desolate districts, while Columella (7.3.18) mentions keeping young lambs in a pen fenced with willows.

Several types of sheep are mentioned and distinguished primarily by the quality and colour of their fleece (Col. 7.2.3-4). Both Pliny (*NH* 8.72.189) and Columella (7.2.5) separate two principal types: a soft-fleeced jacketed variety, and a shaggy-coated farm-breed which requires a delicate pasture. Wool quality was of utmost importance in choosing animals. White rams were generally preferred since their progeny would always be white (Col. 7.2.4-5). White wool was ideal since it could easily be dyed any colour; however, Columella (7.2.4) notes the high price obtained from the wool of black and dark brown sheep from Liguria in the Italian Riviera. Pliny (quoting Virgil, *G.* 3.387) superstitiously claims the lambs would be the colour of the veins under the tongue of the parent ram, and that changing its water could vary the colour of a sheep's fleece (Plin. *NH* 8.72.189). Pliny (*NH* 8.191) and Juvenal (6.149-150) make reference to the tawny fleeces obtained from sheep in Canusium, near the Adriatic coast; however, Pliny (*NH* 8.7.190) holds wool from Apulian sheep in southern Italy, especially those around Tarentum, in highest esteem. Varro (*Rust.* 2.2.18), Petronius (*Sat.* 38), Martial (2.46), and Horace (*Odes* 2.6.10) agree that this fine white wool is among the best. Varro (*Rust.* 2.2.18) even includes special instructions for Tarentine sheep, such as paving their stalls with stones so that their wool might not be damaged by puddled urine. Columella (7.2.3, 4.3) also recognizes the quality of Tarentine wool, but claims that the sheep in Gaul and northern Italy were considered more valuable during his time. Strabo concurs, noting the large flocks pastured in Liguria (Strab. 5.3.1) and the exceptionally fine wool produced in areas of northern Italy such as the region round Mutina (Strab. 4.4.3, 5.1.12), but also upholds the importance of southern Italy as a wool producer (Strab. 6.3.6), offering special praise for the soft wool from sheep raised in the neighbourhood of Monte Gargano in Apulia (Strab. 6.3.9). The legal inscription found near Genoa (*CIL* 1.2.584), and dating to 117 BC, lends further support to the claim of Liguria as a sheep producing area.

The size of sheep varied depending on the geographic region. Columella (7.2.3) states that flat country supports tall sheep, a lean and hilly region those of square build, while a wooded mountainous land produces small sheep. Furthermore, rams should have large horns in localities where the climate is damp and windy to protect their heads, but those with curling horns, and better still hornless rams, are considered more useful (and less threatening), and are preferred in milder regions (Col. 7.3.3-4). Dangerously aggressive rams apparently could be restrained by boring a hole in the horn close to the ear (Plin. *NH* 8.72.188; Col. 7.3.6), which is probably intended for tethering.

Proper care was vital to perpetuating a healthy stock, for a principal aim in sheep-rearing was to produce a disposable surplus of sheep (Col. 7.3.13). Quality pasture was ideal (Verg. *Ecl.* 1.48-49), especially during later Republican and Imperial times when it ranked high on the list of important components of a successful farm. Virgil (*G.* 2.195-202) mentions both Tarentum and Mantua (in northern Italy) as excellent pastures for sheep (although his report of Mantua may be biased—it was Virgil's home region). Sheep were to graze with their backs to the sun (Plin. *NH* 8.75.199; Col. 7.3.8; Varro *Rust.* 2.2.11). They should be fed properly year round (Varro *Rust.* 2.2.7; Col. 7.3.9), with special attention given to fat sheep (Verg. *Ecl.* 6.4-5), perhaps alluding to their value as a meat source. Cato (*Agr.* 5.8, 6.3) and Virgil (*G.* 2.435) state that poplar, elm, oak, willow, and broom leaves provide good fodder, and farmers are cautioned to collect enough of this during autumn to use throughout the winter (Cato *Agr.* 5.8, 30.1; Calp. *Ecl.* 5.106-111). Calpurnius (*Ecl.* 5.51-52) mentions that flocks could be led to feed in woodlands (noting the herds of the Lucanian forests [Calp. *Ecl.* 7.17]) and in pastures at a greater distance from home but only at the end of the spring season, when there was less of a chance that the weather could change dramatically. In cold weather, sheep are said to have no gall, since they must remain penned at this time, and often receive insubstantial fodder (Ael. *NA* 16.26). This changes in spring, however, when they are released to feed on new growth (Ael. *NA* 16.26), after the appropriate sacrifices have been made of course (Calp. *Ecl.* 5.24-25). In summer, flocks left the fold to feed in pastures at dawn (Macrob. *Sat.* 1.17.41; Ovid *Fast.* 4.765-766; Verg. *G.* 3.325-326; Varro *Rust.* 2.2.10; Calp. *Ecl.* 5.52-55), when the grass was fresh with dew (Lucr. 2.317-320; Nemes. *Ecl.* 1.6-8; Col. 7.3.23), and returned home from feeding just before night (Nemes. *Ecl.* 3.67; Verg. *G.* 3.336-338; Varro *Rust.* 2.2.11; Calp. *Ecl.* 5.64-65). The same pasture lands apparently provided excellent feed for other animals as well. Lucretius (2.661) and Pliny the Younger (*Ep.* 2.17) both note the presence of cattle, horses, and sheep concurrently cropping food from one field.

Shepherds apparently tried their best to control flocks of sheep. They were warned not to let the flock go too far ahead (Verg. *Ecl.* 3.94; Col. 7.3.26); some even attached bells to their sheep's necks to avoid losing contact (Sid. Apoll. *Carm.* 2.2.part 14), even though some inherent control is implied in Lucretius' (2.369) statement that "lambs follow their mothers." There are, however, references to several problems in flock management. Farmers were advised to construct hedges or fences in spring in order to keep flocks away from tender leafbuds (Verg. *G.* 2.371-375). Wolves seem to be the biggest external threat. Macrobius (*Sat.* 1.17.41), Virgil (*Ecl.* 2.62-64, 3.80, 5.60), Petronius (*Sat.* 62), Sidonius Apollinaris (*Carm.* 7.364-368), Tibullus (1.1.33-36), Horace (*Ep.* 2.59-60), Ovid (*Fast.* 4.766), Fronto (*Ep.* 4.1), and Aelian (*NA* 7.27) all mention this danger. Horace (*Epod.* 16.51) also recognizes the bear as a menace. Disease was a significant killer. Columella (7.5.1-22) and Cato (*Agr.* 96.1) describe a number of ailments and supply some remedies as well. Lucretius (6.1235-1237) rates contagious disease as the chief cause of death in sheep and goat herds; Juvenal (2.78-79) reports the speed of infection and subsequent havoc rendered by a plague of scab, while Virgil (*Ecl.* 1.46-50) warns that with the occasional mixing of neighbouring flocks, sheep can sometimes infect one another with disease. Large herds were especially vulnerable to epidemics, which is why Varro (*Rust.* 2.1.24, 2.2.20) recommends that shepherds divide their flocks into smaller bands. Blight, and hot, scorching weather also took their toll on the flock (Hor. *Ep.* 16.61-62), especially since heat diminished milk supplies in ewes (Verg. *Ecl.* 3.98-99). Robbers were another threat (Ulp. *Dig.* 47.8.2; Tib. 1.1.33-36; Hor. *Epist.* 1.7.86; Mart. 6.19), but presumably one which was not too significant, at least during earlier times (Calp. *Ecl.* 1.38-41).

Calpurnius (*Ecl.* 5.84-85) instructs shepherds that ownership disputes can be solved by branding sheep.

Since Tarentine wool was esteemed—maximum price of 175 *denarii* per pound in the Edict of Diocletian (25.1), compared to 50 *denarii* per pound for the best middle quality wool (*Ed. Diocl.* 25.4)—these sheep required the greatest of care from their owners. Because they did not tolerate heat or cold very well, they were often maintained inside the sheepfold throughout the year, and consequently required lots of fodder (Col. 7.4.1-2). Neither the lambs, nor the ewe's milk, brought much profit, the object being the raising of mature sheep for wool exploitation (Col. 7.4.3). Relatively more male Tarentine sheep were to be reared to adulthood than males of other sheep types, because a mature Tarentine fleece was highly prized (Col. 7.4.4).

Of all aspects of sheep management, the Roman agronomists devote most attention to the topics of lambing and shearing. After all, these had to accommodate the complexities of the chosen herding scheme, be they nomadic movements, transhumance, or folding and stall feeding.

Ewes less than two years were not allowed to breed (Plin. *NH* 8.72.187; Varro *Rust.* 2.2.14), while three year olds were preferred (Varro *Rust.* 2.2.14). Similar ages were likely observed for rams, which also seemed to prefer mature ewes for mates (Plin. *NH* 8.72.188). Both could breed until nine or ten years (Plin. *NH* 8.72.187), although Palladius (8.11) states rams are only good until eight years and ewes for five. Maximum life-spans hover near ten (Plin. *NH* 8.75.199). Mating occurred sometime between mid-April and mid-July (Col. 7.3.11; Plin. *NH* 8.72.187; Varro *Rust.* 2.1.18; Pallad. 8.11). At this time rams, which had been separated from the flock and fattened two months prior, were brought in to mate with the ewes (Varro *Rust.* 2.2.13). Rams were again removed from the rest of the flock after all the ewes had conceived, to minimize complications caused by their aggressive behaviour (Varro *Rust.* 2.2.14). Lambs would be born from mid-September to mid-December, after a gestation period of five months (Plin. *NH* 8.72.187; Varro *Rust.* 2.1.19, 2.2.14). This coincides with the period when flocks, or at least pregnant ewes and lambs, might be stalled (Verg. *Ecl.* 1.33-35), presumably in lowland farm areas (Verg. *Ecl.* 7.14-15). A permanent location is also alluded to by Varro (*Rust.* 2.2.14) who warns that ewes should drink the same water throughout their pregnancy. Although lambing times could vary depending on when the farmer or shepherd decided the flock could mate,[41] the Roman agronomists agree that autumn and winter lambs are preferred to spring ones (Col. 7.3.12). Pliny (*NH* 8.72.187) explains that it is more important for lambs to be well-established before midsummer (presumably for the trek to upland pastures) than before mid-winter, and that this animal alone is advantageously born in winter. It appears no other animal species was similarly bred to obtain winter newborns. Since birthing could be stressful for the pregnant ewe, shepherds and farmers were advised to know basic veterinarian medicine (Col. 7.3.16). Special feeding routines were observed with young lambs until they reached four months (Varro *Rust.* 2.2.17). It is possible that this diet consisted primarily of ewe's milk. Ovid (*Fast.* 5.497-499) mentions lambs still feeding from the ewe during May. Whether or not these are spring-born individuals or five/six month old lambs (i.e., winter born ones), however, is unknown. Lambs were not to be castrated until after five months (Varro *Rust.* 2.2.18; Plin. *NH* 8.75.198), but Tarentine sheep had to be older than two years (Col. 7.4.4).

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[41] Palladius (8.15) mentions that there were some men who let their sheep breed at any time of the year; Corydon (Verg. *Ecl.* 2.19-21) brags that his Sicilian flock of a thousand sheep can provide fresh milk (and therefore breed) throughout the year, while the shepherd Idas (Calp. *Ecl.* 2.68-70) is able to make fresh "snow-white" cheese from his thousand Tarentine ewes all year round.

Shearing, on the other hand, took place from the end of March to June in temperate climates (Pallad. 6.19) but usually during April in warmer regions (Pallad. 5.21; Calp. *Ecl.* 2.78-79, 5.66-67). Columella (7.4.7) notes that the weather must be neither too hot nor cold. Springtime shearing was certainly a major activity for both pastoral shepherd and Roman populace. The ancient authors offer little information about the locations and economics associated with these activities, but there is a vast amount of modern discussion on these topics (Frayn 1984; Whittaker 1988). Apparently, sheep were washed to clean the wool, examined and treated for scabs or sores (Varro *Rust.* 2.2.6-9), and sometimes dyed prior to shearing (Macr. *Sat.* 1.16.12; Verg. *Ecl.* 3.94, 4.42-45; Verg. *G.* 1.272). Moreover, shepherds were to separate the sheep according to the quality of wool, and package the several kinds of wool in separate bundles (Calp. *Ecl.* 5.69; Verg. *G.* 3.386). Shearing seems to have occurred outside, and during the hottest part of the day. Varro (*Rust.* 2.2.9) notes that the fleece is rendered softer, heavier, and of better colour by sweat.

Columella (7.3.13) states that surplus lambs were to be sold to the town butcher (at apparently a high price according to Aelian [*NA* 16.32]) for their tender meat, and so that their mothers might be milked more effectively for cheese-making. Virgil (*Ecl.* 1.33-35) repeats this remark, while indirectly timing this event to the late-winter or early spring months when the lambs marked for slaughter would be leaving their stalls. Nemesianus (*Cyn.* 152-1523) confidently adds that because sheep are teeming with milk in the spring, that season is known as the milk season. Ovid (*Fast.* 5.497-499) also notes that ewes are full with milk at this time. Although both Columella and Virgil allude to the fact that there was a great urban demand for lamb, only Columella (7.3.13) cautions that to perpetuate the stock at least one lamb in five had to remain with its mother. Calpurnius (*Ecl.* 5.36-37) and Virgil (*G.* 3.176) similarly advise that the economic demand for cheese should not act to deprive all lambs of milk. Virgil (*Ecl.* 3.3-6) explains the negative repercussions of excessive milking—"the flock are robbed of strength and the lambs of milk." Shepherds were obliged to substitute the same number of sheep, or even more, in place of those which had died or were diseased (Col. 7.3.14); however, they were also to sell feeble, blemished, and old sheep in the autumn (Pallad. 8.15; Col. 7.3.14; Cato *Agr.* 2.7).

Finally, mention should be made of the social position of shepherds, since this has some bearing on the incidence and prevalence of sheep raising. Despite the value of resources provided by sheep in Roman times, shepherds themselves were considered to be lower class people (Mart. 7.80). Their maximum wage of 20 *denarii* per day (*Ed. Diocl.* 7.18) makes it amongst the poorest paid of all professions. Most other workers received at least 50 *denarii* per day. Varro (*Rust.* 2.2.20) recommends having one or two shepherds for every 100 sheep (depending on the variety).

Goats

Many of the practices for sheep also apply to goats. The two species often co-occur and their care is similar (Varro *Rust.* 2.3.7; Ael. *NA* 5.48). However, there are several important differences. First, goats, usually headed by a male (Col. 7.6.4; Petron. *Sat.* 133; Verg. *G.* 9.22-25; Tib. 2.1.57-58) often lead the flock of sheep (Ael. *NA* 7.26) for they have a sharper perception than any other cloven-hoofed animal (Ael. *NA* 1.53). Sheep are much more obedient animals than goats, and considered simple followers. According to Virgil (*Ecl.* 4.21) goats did not even have to be called to return home. Second, unlike sheep, goats prefer thickets to meadows and are best pastured in rough and wooded districts (Col. 7.6.1; Varro *Rust.* 2.3.7). They also reside in mountainous areas (Lucil. 3.102-105, cf., Aul. Gell. 16.9.3). Third, milk and meat were the principal commodities exploited of goats, while the black, thick, glossy, and very long hair from male goats (Col. 7.6.2; Mart. 8.51) was used in limited contexts for clothing (Plin. *NH* 8.76.203; Ael. *NA* 16.34), especially during earlier times (Caecil. *com.*), or for making ropes and cloths particularly for nautical purposes (Varro *Rust.* 2.11.11; Ael. *NA* 16.30; Verg. *G.* 3.311-313). Macrobius (*Sat.* 5.11.18) states that goat hair can be made finer if the goat, as a kid, is fed on ewe's milk. In the same fashion, lambs fed on goat's milk were said to produce coarse wool.

Goats have a voracious appetite, eating even what we consider poisonous substances (Lucr. 4.640-641, 5.899-900; Varro *Rust.* 1.2.18), and can cause considerable damage to forests and fields (Plin. *NH* 8.76.204; Mart. 3.24, 8.51; Verg. *G.* 2.195-202, 2.375-381; Macr. *Sat.* 7.5.7; Ov. *Fast.* 5.354-358; Varro *Rust.* 1.2.18, 2.3.7). Although they are best pastured in rough and wooded districts (Col. 7.6.1; Varro *Rust.* 2.3.7; Macr. *Sat.* 1.17.63), Pliny (*NH* 8.76.204) asserts that control over the goat herd is imperative since "their bite kills a tree." He further comments that they should not be offered in sacrifice to the goddess Minerva because "they make an olive tree barren even by licking it" (Plin. *NH* 8.76.204). It is likely that for these reasons coupled with the tendency for epidemics to spread rapidly among the herd (Varro *Rust.* 2.3.10; Hor. *Epist.* 1.7.86) that goats were kept in smaller numbers than sheep. A flock of 50 was considered large enough, but some areas (Varro [*Rust.* 2.3.10] mentions Sallentum and Casinum) had herds as high as 100 (Varro *Rust.* 2.3.10). Columella (7.6.5) warns that one ought not keep a larger number than 100 in a single enclosure. Interestingly, there is more mention of herds of she-goats (Calp. *Ecl.* 5.5-6, 5.14-16) than of mixed flocks of both sexes.

Stalls or stables for goats should "face the sunrise in the winter as the animals feel the cold acutely" (Varro *Rust.* 2.3.6). They should also have a stone or tile floor, since no litter is provided for this animal (Col. 7.6.6), and such surfaces prevent the goat-house from becoming wet and muddy (Varro *Rust.* 2.3.6). Varro (*Rust.* 2.3.6) recommends this flooring for all animal stalls.

Varro (*Rust.* 2.3.2) distinguishes two breeds of goats, those with a thick coat of hair and those which are hairless, but he does not mention any size distinctions separating them. Male goats were chosen for their coats (Col. 7.6.2), while females with large udders were desired (Varro *Rust.* 2.3.2). Goats produced abundant quantities of milk which was integral to the cheese industry. Although Varro (*Rust.* 2.11.1,3) rates goat's milk (and cheese) as both less nourishing and more of a laxative than that of sheep, Pliny (*NH* 8.76.202) makes note of a method to increase the supply of milk in the goat (by removing the horns) but does not even mention sheep's milk. Similarly, in several passages Virgil (*Ecl.* 4.21-22, 7.3-4, *G.* 3.308-310, Minor Poems 2.10-15) speaks of both sheep and goats, but specifically describes the latter animal as "swollen with milk." Horace (*Epist.* 16.49-50) also recognizes the capacity of the goat to yield much milk, while Varro (*Rust.* 2.3.10) claims that goat's milk was costly enough to bring in HS4 from each animal per day, at least in Rome, where prices were generally much inflated.

Male goats are ready for breeding purposes at seven months (Col. 7.6.3), but are not very useful as sires until three years old, and thereafter are only good for another two (Col. 7.6.3) or four years (Plin. *NH* 8.76.200). Similarly, females are not good for breeding until three years old, and can breed until they are eight (Col. 7.6.8). They are covered at the close of autumn, around December, so that kids (rarely more than four at one time, according to Pliny [*NH* 8.76.200]) will be born four or five months later in the spring when the buds are on the trees (Varro *Rust.* 2.1.19; 2.3.8; Plin. *NH* 8.76.200; Col. 7.6.6; Verg. *G.* 2.524-525). According to Pliny (*NH* 8.76.200) both sexes breed better with their horns removed, although not all breeds have horns (Plin. *NH* 8.76.202). Stock ratios of one male to every ten, fifteen, or twenty females are suggested (Varro *Rust.* 2.3.10).

Kids are reared in a similar manner to sheep (Col. 7.6.7), but with some differences. Twins are frequent among goats (Col. 7.6.6-7; Verg. *Ecl.* 1.12-14). Columella (7.6.7) suggests to keep one, and hand the other over to the dealers. Furthermore, mother-goats less than one year are to be immediately deprived of their offspring (Col. 7.6.8), which were perhaps to be sent to the market.

Integration

Zooarchaeological data about sheep/goat in Roman Italy correlate with a number of references in the ancient texts. Each supplies information about animal size, husbandry, health, and resource exploitation which, when combined, provides a broader picture of the role of sheep and goats in antiquity.

The texts mention that sheep were common animals at most farms (Varro *Rust.* 1.19.3), principally raised for their renewable secondary resources such as wool and milk (Col. 7.3.13). They were particularly valued during Republican times and herded, sometimes as great transhumant flocks, throughout Italy, although more mention is made of southern and northern Italy. Goats co-occur with sheep and their care is similar (Varro *Rust.* 2.3.7; Ael. *NA* 5.48); however, fewer of them are kept and their herds are normally much smaller than those of sheep (Varro *Rust.* 2.3.10). Available zooarchaeological data confirm these textual references to a certain degree. Sheep/goat register higher NISP and MNI figures amongst Republican period sites in both southern and central Italy (with the exception of C/1/r sites), but are not well-represented amongst sites in northern Italy until Imperial times. However, only four sites comprise the sample of Republican period sites in northern Italy, as opposed to many more in the case of the other two regions. Sheep usually predominate over goats at most sites; average ratios hover around four sheep to every goat. Aging and sexing data show a predominance of adult females at some sites, thereby supporting references about the importance of wool and milk exploitation, while a combination of zooarchaeological data from frequency, age, sex, and size analyses hint at various kinds of herding operations, including transhumance.

Much has been written about the wool industry in antiquity.[42] If we include all social, political, economic, and cultural aspects associated with wool retrieval, processing, spinning, weaving, etc., not to mention the great deal of theorizing and speculation made about the wool industry, the topic becomes much too vast to deal with completely in this study. Therefore, any discussion of wool will be made in the context of sheep and goat husbandry schemes as revealed in the zooarchaeological and textual evidence solely.

Sheep outnumber goats at most sites throughout Italy, on the basis of the zooarchaeological data. This pattern is generally consistent in southern and central Italy, where the majority of sites register over 80% sheep to less than 20% goat by NISP figures (see Table 30). Most of the exceptions to this pattern are either sites with smaller sample sizes (e.g., Capaccio, San Potito, Le Colonne), which can skew results, or they are special deposits (e.g., Locri, Gravetta, San Omobono, Lugnano-cemetery) which need not necessarily reflect typical husbandry or dietary schemes of the area. The zooarchaeological patterning accords with textual references alluding to the importance of wool production in the economy of Republican southern and central Italy. Less can be said about temporal changes in specific regions but overall the zooarchaeological patterning suggests a decline in wool production relative to other aspects of the Roman economy from Republican to Imperial times, with a slight resurgence in some parts of central and northern Italy during Late Antiquity. This general trend parallels the shifting demands for garment materials. Wool dominated the textile market during Republican and early Imperial times until linen began to advance in popularity during the 1st century AD (Frank 1933-40, vol. V: 156 [on linen]; White 1970a: 303). The return, in some areas, to sheep-raising during Late Antiquity may in part reflect a decline in linen imports into Italy at these times, or a change in fashion. A number of economic, social, and political factors likely also had some type of impact (e.g., shift to small-scale pastoral life, loss of political control of Roman provinces, warfare, etc.), but these issues are beyond the scope of this thesis.

The high frequency of goat bones from the site of Otranto accords with one comment in the ancient texts. Varro (*Rust.* 2.3.10) states that flocks of 50 goats are considered large, but that some areas, specifically Sallentum and Casinum, have herds as high as 100. Otranto and Sallentum are both located in south-eastern Italy, in what forms the "heel" of the "Italian boot." Thus, this area is predisposed to have a sizable population of goats, which is verified in the faunal record. Goats can survive better than sheep in the rougher pastures of this region of southern Italy. Moreover, we might expect more goats to be raised near port cities, like Otranto, in light of textual references for the use of their hair to make rope and cloths, especially for nautical purposes (Varro *Rust.* 2.11.11; Ael. *NA* 16.30; Verg. *G.* 3.311-313). A similar argument might explain the preponderance of goats at Locri (on the Ionian coast), and even Carminiello (Bay of Naples area); however, there are surely a host of other natural and cultural factors to consider. Male sheep/goat are much more prevalent at Otranto than at other sites in southern Italy such as Gravina and Cozzo Presepe, which might be expected if the hair of male goats was preferentially exploited for nautical purposes (Col. 7.6.2; Mart. 8.51). No sheep/goat sex data are available for Locri and Carminiello, but rams/male goats do predominate amongst samples from nearby Pompeii-Ganimede (also in the Bay of Naples area).

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[42] Some of the more comprehensive works include: Frayn 1984; Jones 1974; Jongman 1988; Moeller 1976; Morel 1978; Ryder 1983.

Most of the sites in northern Italy record more sheep than goat remains, anywhere from four to nine times the number. One site, however, stand outs. Stufels contains relatively more goats than other sites. Goats prefer thickets to meadows while feeding, and are best pastured in rough and wooded districts. Even Columella (7.6.1) and Varro (*Rust.* 2.3.7) recognized this fact. The Alpine slopes and forests around Stufels would offer ample prime grazing land for goats, but if this was the sole reason for keeping goats then why are they so poorly represented at other Alpine sites such as Innichen and Invillino? It is possible that occupants at Stufels kept more goats for milking. Goats do produce greater quantities of milk than sheep.[43] Balancing this with sheep would then provide the occupants of Stufels with milk (principally from goats), wool (from sheep), and meat (from both), thus making the site reasonably self-sufficient in terms of caprine resources. Fairly balanced sex ratios for caprines at Stufels implies a closed system, with only minor cultural intervention. That Innichen and Invillino raised fewer goats, relative to Stufels, attests to different economic and dietary strategies at these sites. Available faunal evidence suggests that wool exploitation may have been prominent. This also appears to be the case at most other sites in northern Italy where sheep predominate over goats (e.g., Modena, Colognola, Lomello, Palazzo Dugentesco).

Although the texts name a number of areas throughout Italy where sheep pastured, several zones appear with more regularity. These include the whole of southern Italy in general, but Apulia, Calabria, and the Tarento region especially (Col. 7.2.3; Strab. 6.3.6, 6.3.9; Plin. *NH* 8.7.190, among others), the Samnite hills and Ligurian region of central Italy (Varro *Rust.* 2.1.16; Strab. 5.3.1), and areas of northern Italy including cis-Alpine Gaul, Altinum (near Venice), and the region around Parma and Mutina (Col. 7.2.3; Strab. 4.4.3, 5.1.12, 5.3.1). The best-quality wool comes from sheep raised at higher altitudes, in regions which receive low rainfall (White 1970a: 301). Most of the sites and areas mentioned above correspond to these conditions. Nearly all (save perhaps Liguria) are located on the drier eastern side of Italy. The ancient authors describe the colour, length, texture and price of sheep wool from these various regions (e.g., soft, prized wool of Tarentine sheep, yellow/tawny wool from Canosa, etc.), but provide few details about size or shape differences amongst these breeds. In fact their whole discussion of the conception of sheep breeds is very crude. Columella (7.2.3) refers to three types of sheep—tall sheep in flat country, sheep of square build from lean and hilly regions, and small sheep from the woods and mountains—but he does not characterize specific breeds as falling into any of these types. Varro (*Rust.* 2.2.2f.) and Pliny (*NH* 8.75.198) add that well-bred sheep have short legs, which again tells nothing about specific sheep breeds.

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[43] About four times the amount by body weight (White 1970a: 315).

Zooarchaeological data affirm the geographic information about sheep raising from the texts. Sites in southern Italy, especially those in Apulia and Calabria (e.g., Gravina, Monte Irsi, Cozzo Presepe, San Biago, Otranto), record amongst the highest NISP and MNI sheep/goat frequencies of all sites in Italy. Several other sites in the western region of southern Italy (e.g., Roccagloriosa, Capaccio, Kaulonia) also register high sheep/goat frequencies. Sheep/goat claim anywhere from one-third to over one-half of all mammalian NISP amongst these sites. Columella's correlation of sheep size with geography stands true in the case of southern Italy. The average withers height of sheep from Republican period sites in relatively flatter areas is 66.5 cm (n=58, from Gravina and Monte Irsi), which is 1 cm taller than that of sheep from contemporary but more mountainous regions (n=3 from Locri). Zooarchaeological data also tabulate a slight size increase amongst sheep/goat in southern Italy over time, which suggests some measures were taken to improve breeding and produce larger stock. However, this increase is not large enough to conclude such breeding schemes had a dramatic impact.

Overall, sheep and goats are of less importance amongst rural and settlement sites in central Italy than elsewhere, aside from those sites in Samnium and Liguria. Matrice (in Samnium) registers some of the highest sheep/goat NISP and MNI frequencies of all rural and settlement sites in central Italy, regardless of time period, while Late Antique Luni (in Liguria) has a relatively high NISP value for sheep/goat. Sheep and goats do contribute varying amounts of meat to the diet at urbanl sites in central Italy, but it is unknown to what degree these animals were herded locally and thus indicate husbandry schemes from the immediate zone outside the city (i.e., especially around Rome and the Bay of Naples area, where these urbanl bone deposits concentrate). Some (many?) could have been imported from southern and/or northern Italy. In terms of size differences, the zooarchaeological data for central Italy support Columella's (2.3.7) comments. Available withers heights from Late Antique sheep/goat in central Italy provide an average of 69.8 cm (n=35) for sheep/goat consumed in the Bay of Naples area (measurements from the sites: Carminiello, Girolamini, S. Patrizia), and 68.4 cm (n=21) for sheep/goat consumed at sites located in the lowland areas in or around Rome (measurements from Settefinestre, Lugnano, Schola Praeconum, and Via Gabina-site 10), but only 66.5 cm (n=4) for sites in more mountainous regions (measurements from San Giacomo and Matrice). Thus, sheep from montane areas in central Italy are generally smaller than their lowland equivalents. Zooarchaeological evidence also shows an increase in the average size of sheep in central Italy from Republican through Imperial to Late Antique times, presumably the result of improved breeding schemes.

The sheep/goat zooarchaeological data from sites in northern Italy generally complement the textual evidence. Sites in the Alpine area of northern Italy (e.g., Innichen, Stufels, Invillino) all register more than 40% sheep/goat by total NISP counts, the most of all animals. Torcello, near Venice, also has an excess of sheep/goat bones, but neighbouring Altino (ancient Altinum) does not. Modena (ancient Mutina) contains nearly 40% sheep/goat bones. These three areas are specifically mentioned in the ancient texts as prosperous sheep rearing zones. Another spot not expressly mentioned in the texts but associated with a large proportion of sheep/goat bones is the region around Pavia (ancient

Ticinum). Both sites located in this area—Palazzo Dugentesco and Lomello—contain a relative abundance of sheep/goat bones. The average size of these north Italian sheep/goat, however, does not agree with Columella's statement. Available measurements for mountain sheep (e.g., Innichen, Stufels, Invillino) give an average withers height of 69.4 cm (n=41), while the average sheep from relatively flatter areas such as Modena and Pozzuolo del Friuli is smaller by comparison (64.6 cm, n=12). This may be a factor of the number of sheep herded in each area. Shepherds in the lowland regions may have preferred to keep larger flocks of smaller-sized sheep and goats which were presumably easier to control. It is possible that this size discrepancy reflects different sheep and goat breeds raised in these two areas, but this is difficult to prove on the basis of zooarchaeological evidence alone. Both areas display a great range in withers heights. The average Republican period sheep from northern Italy is the smallest of all time periods and regions in Italy. The mean size jumps a few centimeters during Imperial times, presumably due to enhanced breeding, and perhaps the result of the introduction of new breeds. This value declines, however, almost back to Republican period levels, during Late Antiquity.

The zooarchaeological trend of enhanced sheep production in northern Italy from Republican to Imperial times accords with the Columella's (7.2.3) comments about the importance of this region for producing wool. White (1970a: 506) suggests the north Italian sheep were improved to produce better-quality wool than most southern Italian breeds (Col. 7.2.3). Varro (*Rust.* 2.2.3) adds that the north Italian wool was in great demand at the market during his time. The emphasis on wool quality (of which northern Italy gained prominence), therefore, seems to have risen against that of wool quantity (of which southern Italy was renowned) which was stressed in earlier periods (White 1970a: 506).

While the zooarchaeological data indicate that sheep were kept and consumed at many of the rural and settlement sites in Roman Italy, and formed part of the diet at nearly all urban sites, it is difficult to estimate the size of the herd and the scale of operations on the basis of NISP and MNI figures. Numbers quoted in the texts range from a few sheep kept around the farm to supply manure (Varro *Rust.* 1.19.3, Alf. *Dig.* 32.60.3) to around 100 for an olive farm of 240 *iugera* (Cato *Agr.* 10.1) to huge transhumant flocks of 700, 1000, or more (Varro *Rust.* 2.10.11). Moreover, the scale of pastoral operations varies from localized, small, non-transhumant herding at a permanent settlement, to large-scale, long-distance transhumance. Sites where sheep/goat account for less than one-third of the total mammalian NISP and MNI figures seem less likely to be involved directly in large-scale herding operations such as long-distance transhumance, although it is possible that some of these sites, especially those lying en route to summer or winter pastures, received sheep and goats from such flocks making these journeys. On the other hand, rural and settlement sites where sheep/goat NISP and MNI figures tower above 40 and 50% probably kept more than just a few sheep/goat around the farm, and may have had transhumant flocks, but it is difficult to determine both the scale and distance involved. There are essentially two scales of transhumance (i.e., large and small), which can be practiced over long or short distances. Generally, larger-scale transhumant operations involve great distances, while small-scale ventures are often restricted to short-distance movements within a restricted area, but these patterns need not be fixed.[44]

The argument for large-scale operations is strengthened in many cases when we combine large NISP and MNI values for sheep/goat with relatively abundant stall space. Although this not need preclude transhumance over long-distance, in order to avoid having these stalls empty for half the year, I would expect sites with plentiful stall space designed for caprines to be associated with non-transhumant or short-distance transhumant schemes, wherein flocks were perhaps housed for longer periods throughout the year. Archaeological evidence for just a few stalls places restrictions on the number of animals which could have resided on site year-round, especially when we consider statements made by the ancient agronomists about stalling sheep and goats during the winter or during pregnancies. There are complications, however, when we consider the loss of less permanent structures, such as wooden stalls, in the archaeological record, as well as changes in the use of certain rooms, and the general limits of archaeology (i.e., only a sample of a site or region can be excavated, which may not include animal stalls). Thus, much of what the ancient authors have to say about temporary pens, shelter, corrals, and other enclosures for sheep and goats cannot be verified by archaeological evidence alone.

From the zooarchaeological data available for sheep/goat in Roman Italy, I would suggest that larger flocks of sheep and goats were kept at the following sites: Gravina, Monte Irsi, Roccagloriosa, Kaulonia, Cozzo Presepe, San Biago, San Giacomo, Narce, Populonia, Luni, Modena, Stufels, Innichen, Invillino, Torcello, Palazzo Dugentesco, and Lomello. All of these sites register comparatively large caprine NISP and MNI figures, thereby suggesting some popularity of sheep and goats. Moreover, with the exception of Narce and Populonia, all of these sites lie within regions mentioned in the texts as important sheep raising areas. Narce and Populonia, however, date to Republican times, when sheep/goat husbandry was more universally practiced in Italy. Gravina, Monte Irsi, and Cozzo Presepe may have engaged in long-distance transhumance, while smaller-scale movements may have occurred between lowland and montane sites in northern Italy.

Although Varro's (*Rust.* 2.1.16, 2.2.2.10, 2.10.11) references inform us that transhumance was evidently well established in Italy by the 1st century BC,[45] it is difficult to identify this practice solely on the basis of zooarchaeological evidence. It depends on a number of assumptions about seasonal mating, resource exploitation, and population of a flock. Moreover, the scale and distance of many transhumant operations would depend upon political, social, and economic factors as well. The Saepinum inscription (*CIL* 9.2438; Corbier 1983), for example, outlines some of the problems and repercussions associated with the movement of flocks. If anything, the fact that some pastoral operations were regulated by the Roman government, as evidenced by the Saepinum inscription in particular, attests to the important roles sheep rearing and the wool trade fulfilled in the Roman economy.

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[44] Chang (1984) and Chang and Koster (1986) discusses the various scales of pastoralism and transhumance from an ethnoarchaeological perspective. Barker (1989, 1990b) and Barker and Grant (1991) provide further discussion based on ethnoarchaeological studies of pastoralism in central Italy.

[45] Pasquinucci (1979: 93-94) makes a generalized statement in support of a pre-Roman origin for long-distance transhumance (largely based on archaeological data), but it was probably unstable at this time and caution is required in estimating the scale. Skydsgaard (1974: 13) argues that transhumance was practiced during the 2nd century BC on the basis of a reference in Cato (*Agr.* 149-150) outlining a standard contract for leasing winter pasture.

Regardless of the scale of operations, the basic pattern of transhumance has flocks moving on a seasonal basis in order to take advantage of grazing-grounds. They spend the summer months in the mountains, and the winter months on the lowland and coastal plains. The location of the permanent settlement determines the form of transhumance. In normal transhumance, the permanent settlements are in the lowland areas and the flocks are driven up to high mountain pastures for the summer; in inverse transhumance the permanent settlements are in the mountains with the flocks driven down to the lowlands and coastal plains for the winter (Skydsgaard 1974).

Large-scale transhumance was likely geared towards the production of wool (Pasquinucci 1979) with a larger proportion of animals reared to adulthood, including perhaps a higher proportion of males and even castrates (Barker and Grant 1991). Herds numbering from several hundred to several thousand would characterize the system. Often large-scale transhumance involved seasonal movement over great distance.

Small-scale transhumant operations may show a different pattern. These could have been geared towards subsistence, depending on how accessible the site was and its relationship to local and distant markets. Flocks were probably herded over comparably shorter distances than those affiliated with large-scale transhumant operations, since smaller pasture areas would be needed. If the sheep were reared as part of a small-scale subsistence venture then milk and meat may have had greater value than wool to the peasant shepherd/farmer. In this case, ewes would predominate. Female lambs would be raised to maturity, while young males would be killed for their meat.

Mating, shearing, birthing, milking, and slaughtering would all have to fit appropriately into the transhumant schedule. Shepherds would certainly be required to monitor the flock closely to make sure it conformed to the often rigid pattern of birthing and movement. They would not want to burden pregnant ewes soon due to deliver with a long journey, nor would they particularly want lambs born en route between pastures (unless these could be sold at a market; they certainly could not travel immediately with the rest of the flock). Both scenarios would surely delay travel and interrupt schedules. According to the ancient sources, lambs were best born in the winter months (Plin. *NH* 8.72.187; Varro *Rust.* 2.1.19, 2.2.14; Col. 7.3.12), which would likely coincide with time spent at lowland and coastal plains, for new born lambs surely could not travel long distances. Those lambs destined to be killed off would probably be slaughtered at the winter grazing-grounds, since there would be little point in taking any but the eldest and strongest of them on the long journey to the summer mountain pastures. Surplus lambs could be sold to the town butcher, as Columella (7.3.13) suggests, and with some convenience considering that most of the larger Roman cities were also located in these lowland and coastal areas. Some ewes could be milked, especially those which had given birth early in the season at the lowland pasture and had their lambs removed right away.

Shearing occurred once or twice a year at the lowland or in the upland pastures (Frayn 1984: 142). Usually this coincided with the time spent at winter grazing-grounds, in an annual scheme. It is unlikely that the fleece was transported any great distance, therefore shearing was probably scheduled when the flock was near a market (Frayn 1984: 142). At this time surplus lambs could also be sold at the market and the flock inspected and prepared for the future (White 1970a: 305). The ancient authors state that shearing took place from the end of March to June in temperate climates (Pallad. 6.19) but normally during April in warmer regions (Pallad. 5.21; Calp. *Ecl.* 2.78-79, 5.66-67). In southern and central Italy, therefore, we would expect an April shearing. This would take place in the lowland areas either right before the flocks were driven to their summer upland pastures, or alternatively while en route to them. They might also be sheared upon reaching the upland area, but in most cases nearby markets would be scarce. In addition, traveling to the summer pastures would certainly be an arduous and hot trek for a full-coated sheep to make. Moreover, there would be an increased chance for the wool to get cluttered with burrs, dirt, and other refuse the longer the animal had to journey unsheared.

Mating would probably occur at the upland pastures, and be controlled in such a way so that ewes gave birth back at the lowland pastures, after a five month gestation period. This would require the females, at various stages of pregnancy, to make the trek down from the mountain pastures to the lowland plains. Although the distance might be considerable, it would be a relatively easy downhill journey for the flock, compared with the exhausting climb five or six months prior.

In terms of sex and age ratios, long-distance transhumance should show an abundance of young lambs (i.e., less than six months), preferably males, at sites in winter grazing areas, since this is where caprines were supposed to be born. This should be followed by very few deaths in the 7-12 month bracket since at this time the flock would be at their summer grazing-ground in the mountains, and presumably away from the lowland settlements. In addition, we might expect to see some deaths of elderly sheep of both sexes in the faunal record for winter (i.e., lowland) grazing areas, considering that shepherds were told to sell and slaughter feeble and old sheep in the autumn (Pallad. 8.15; Col. 7.3.14). This could coincide with the beginning of the season in the lowland, and might be more logical at this time. If the shepherd waited until the lambs were born he would at least know how many were viable and thus he could better judge the required number of old and feeble sheep which had to be killed to balance the flock. However, the selective killing and selling of older sheep might also overlap with the end of the season at the summer pastures or fall within the journey period. Thus, it is less convincing proof for winter-grazing placement than the frequency of lamb deaths.

As shown in Tables 34 - 37 and Appendices 6 - 8, sheep/goat aging and sexing data are limited for most of the Roman period sites in Italy used in this analysis. Of all the sites in southern Italy, only Gravina offers some of the better, although still not conclusive, evidence for long-distance transhumance. The pit deposit at Gravina contains the greatest relative frequency of lamb remains of all sites in Italy. Lamb bones were also recovered at other excavations in the area.[46] This evidence shows that at least some sheep were in the Gravina area during the wintertime, assuming these lambs were not imported. The flock then moved elsewhere in the spring, presumably to mountain pastures, which would account for the low number of deaths in the 7-12 month period. The site of Gravina, however, is rather far back into the Apulian hilly interior, or somewhat removed from the main winter grazing-grounds on the coastal plain. Thus, it may have served as more of a peripheral winter-grazing area. The site of Cozzo Presepe is in a similar position to Gravina (i.e., removed from the coast). Normal transhumance may have been part of its economy even though the aging data do not strongly confirm this. Moreover, several deaths in the 7-12 month age group at Cozzo Presepe would indicate that at least part of the flock remained behind.

According to the sex data, the flocks at both Gravina and Cozzo Presepe were largely composed of adult female sheep. This accords with textual references which indicate first, that ewes were kept to older ages as breeding stock (Plin. *NH* 8.72.187; Varro *Rust.* 2.2.14), and second, that rams were removed from the flock after ewes had conceived (Varro *Rust.* 2.2.14). It is possible that some (many?) of these represent ewes which died during pregnancy or parturition, although there is little corroborative evidence for fetal or newborn deaths. Columella (7.3.16) notes how stressful pregnancy can be, and advises shepherds to know basic veterinarian medicine.

Assuming long-distance transhumance occurred in southern Italy, the winter flocks around Gravina would have to travel to summer mountain pastures. There are two basic options. They could travel west to the Lucanian Apennines or north to the Samnium hills. Calpurnius (*Ecl.* 5.51-52, 7.17) mentions flocks feeding in the Lucanian woodlands at the end of spring and into the summer. Imperial period San Giovanni, a site in this area, registers a preponderance of sheep/goat deaths in the 7-12 month category, with many less at earlier ages. This would imply that few sheep/goat were around San Giovanni during the winter months when ewes were giving birth. Little but stored fodder would be available to them since the area can be covered with snow during the winter months. Thus, what zooarchaeological data are available support the textual references about transhumance in the Lucanian interior.

The ancient texts supply more information about transhumance between southern Italy and the Samnium and Reatine hills of central Italy. Varro's (*Rust.* 2.10.11) own flock apparently made this journey, while the Saepinum inscription (*CIL* 9.2438; Corbier 1983) and a remark in Cicero (*pro Cluentio* 161) attest to some of the conflicts that can arise along the way. Available zooarchaeological data from sites in this area offer some support. First, sheep/goat NISP and MNI values are relatively high amongst sites which are located along or near the main transhumant routes linking southern and central Italy (e.g., San Giacomo, Matrice, Saepinum, Campochiaro). This suggests that these animals were more readily available. Second, few young individuals, less than 12 months, are recorded at all of these sites, on the basis of dental and fusion data. Late Antique Matrice further shows a scarcity of 3-6 month lambs but a relative abundance of deaths at 7-12 months. The lack of young lambs at these sites suggests that birthing occurred elsewhere, presumably in the south, leaving sites like San Giacomo and Matrice tied more towards summer sheep/goat pasturing and associated activities such as wool manufacturing, milk and cheese production, or the processing of mutton, but generally not lamb meat.

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[46] Watson (1992: 98) notes these but does not include them in his dental categories.

Little can be said about transhumance in other areas of central Italy. The texts are silent, perhaps an indication that transhumance was not normally practiced. That the site of Settefinestre has more 3-6 month than 7-12 month sheep/goat deaths suggests it served as a winter pasture area, a logical deduction since it is near the coast. With the exception of perhaps Liguria, most of west-central Italy (i.e., Tuscany, Umbria, Campania, Lazio), however, is poorly suited both geographically and economically for pastoralism than eastern central Italy (i.e., Samnium, Picenum); therefore I expect most of the sheep and goats herded in west-central Italy were part of small local or short-distant transhumant flocks and not large, long-distant, transhumant ones. This is supported by the zooarchaeological evidence which shows much reduced sheep/goat NISP and MNI relative frequencies in this area compared to elsewhere in Italy, especially in the case of rural and settlement sites (see Figure 20).

Although there are a number of textual references to sheep from northern Italy, the pastoral schemes there are still difficult to reconstruct. Sheep and goats certainly formed a major part of the diet and economy of Alpine sites such as Stufels, Innichen, and Invillino, but the data are mixed as to the scale of operation.' Innichen and Stufels-Hotel contain relatively more 3-6 month lambs than 7-12 month individuals, which is characteristic of winter grazing-grounds, while Stufels-Senoner and Invillino show the reverse (i.e., more 7-12 month deaths), which is expected at summer grazing-grounds. These data discrepancies—especially at Stufels, a site which also has a relatively large proportion of goat bones, as discussed above—suggest that long-distance transhumance was not practiced, or at least less commonly practiced, in northern Italy, compared to other areas. Invillino seems the best candidate as a summer grazing-ground for sheep/goat. Dental data here show a predominance of deaths in the 7-12 month category, while sex data report slightly more females than males. We would expect females to predominate if younger males had been selectively killed. These males would not appear in the sex data, since their bones would be too young to reveal any dimorphic features, but their deaths would certainly cause an imbalance in the sex ratio by increasing the number of females living to maturity. Stufels-Senoner also fits the pattern, both geographically and zooarchaeologically, of a summer-grazing ground. However, the fact that its neighbour site, Stufels-Hotel, does not, lends support to the hypothesis that limited transhumance took place at Stufels in general. Rather I would predict that a small local herd was maintained, year-round, at this site. Some individuals may have moved seasonally (over short or long distances cannot be determined), but a supply was always kept on hand. Considering adult female sheep and goats predominate, I suggest that milk and cheese were important commodities. This pattern appears better suited to short-distance transhumant schemes where ewes might have greater prominence, rather than long-distance transhumant operations which emphasize raising wethers and rams for wool. A similar situation is proposed for the site of Innichen, which also contains more female than male sheep/goat bones, although low-milk-producing sheep largely outnumber high-milk-producing goats at this site.

The situation at Modena, in northern Italy, concurs with the expected pattern for a summer grazing area. Lambs are scarcely represented in the kill-off profile; many deaths occur between 7-12 months of age. In the absence of aging and sexing information from other north Italian sites, however, no other predictions can be made about sheep-rearing practices in northern Italy.

Although the zooarchaeological data support the existence of transhumance in Roman Italy, especially in the south, no site documents that activity perfectly, and there are many complications. One problem concerns the urban1 sites. Many of these are located in lowland areas and were presumably supplied with lambs and wool from sheep and goats raised at neighbouring rural farms. Urban1 sites, however, record very few sheep/goat deaths under 6 months, but a sizable number in the 7-12 month category, as shown in Table 35. This initially appears to contradict the criteria presented above for long-distance transhumance which hypothesized an abundance of deaths in the 0-6 month category and a dearth of them in the 7-12 month category for sites associated with lowland pastures. The pattern might be explained if urban1 sites in lowland areas received 7-12 month sheep/goat from the flock as it made its way to the upland pasture. The shepherd could have waited until the lambs were older before marketing them for slaughter at urban centres, perhaps working this into the transhumant scheme so that the flock passed by a city on its journey to the upland pastures. Moreover, the four month span during which sheep and goats were to mate (i.e., mid-April to mid-July [Col. 7.3.11; Plin *NH* 8.72.187; Varro *Rust.* 2.1.18; Pallad. 8.11]) and give birth (i.e., mid-September to mid-December [Plin *NH* 8.72.187; Varro *Rust.* 2.1.19. 2.2.14]) provides a period of flexibility which is not easily adjusted to the age categories given in Table 35 in light of variations in transhumant schemes. For example, a transhumant flock which gave birth in October in the lowland pastures, but remained there until May or June before heading to upland pastures would yield a number of eight month old lambs which could have been sold to urban markets before the flock returned to upland regions. Thus, assuming cities were provisioned with transhumant caprines, then the relatively high number of sheep/goat deaths in the 7-12 month category at urban1 sites as recorded in Table 35 might be attributed to a transhumant scheme characterized by an extended lowland season lasting over six months with a subsequently shortened upland season. If the urban1 sites were not supplied with transhumant animals but rather with sheep and goats raised year-round at individual sites, then the age pattern exhibited would simply reflect local husbandry concerns and urban meat demands, since in this case it is assumed animals would be more readily available for sale and slaughter throughout the year as opposed to the stricter seasonal transhumant schedule which required them to be in upland areas during the spring and summer months.

There is little direct evidence for the scale of sheep-raising in Roman Italy using combined zooarchaeological and textual data. The zooarchaeological data show a range of pastoral operations which operated on a variety of scales within a geographic region or even at one site. The texts generally distinguish two broad systems of sheep husbandry (i.e., folding at the farm and transhumant herding); however, each is not always clearly demarcated, and elements of these apparently separate systems sometimes overlap with their counterpart. Lirb (1993) argues that transhumance should not be viewed as a separate venture from agricultural pursuits (contra. Skydsgaard 1988), but as an integrated activity.[47] This could take on a variety of forms. Transhumant herds could graze and manure the fields of their hosts during part of the year. Reserving leguminous fodder crops for animals in the context of a crop rotation system is another means of integration.[48] Finally, the fact these flocks were away from the farm for a period of time is in effect a type of integration, since this normally coincided with the interval of summer drought, high temperatures and excessive resource stress in the lowlands (Lirb 1993: 270). It was advantageous for the flock to move to higher, cooler pastures at this time. Upon their return they would again be integrated into the agricultural scheme by pasturing among the stubble and weeds while simultaneously manuring the fields, effectively preparing and fertilizing these areas for subsequent planting. Both Cato (*Agr.* 30) and Varro (*Rust.* 2.2.12) advocate the use of sheep in this manner.[49]

Large-scale transhumant operations draw attention from the ancient authors and legal sources, and become more conspicuous in the textual record, even if they were practiced on a relatively small scale, or combined with other, less noteworthy sheep/goat husbandry schemes. Long-distance transhumance would not become the dominant type of pastoralism in Italy unless the Roman government wished it to be (Thompson 1988: 214). The situation in Roman Italy probably resembled Sardinia in the 1930s more than it did the massive operations of sixteenth-century Puglia (Thompson 1988: 214). While Rome's conquest of Samnium had removed the main political barrier to long-distance transhumance of livestock by the early third century BC, suitable conditions may not have arisen until more peaceful conditions reached the south after the Hannibalic Wars (Brunt 1971; Frayn 1984; Garnsey 1988b). Thereafter, in the second century BC, long-distance transhumant pastoralism likely expanded. The fact that most Imperial and Late Antique authors virtually ignore the topic of transhumance, however, may indicate a decline in its practice over time, or at least a reduction in the conflicts and problems it earlier presented. The drop in sheep/goat NISP and MNI values after Republican times in southern and central Italy helps further the argument of reduced transhumant operations in Imperial and Late Antique Italy. Small- and medium-scale non-transhumant or semi-transhumant sheep and goat herding, nevertheless, continued to exist throughout Italy and over the whole Roman period, and collectively probably accounted for more sheep than all of the massive large-scale, long-distance transhumant flocks combined, although lack of data renders this impossible to prove at the moment. These systems too could be, and most likely were, integrated into mixed farming regimes. White (1970a: 310) notes that sheep can graze between the rows of olives grown on land too poor for intercultivation with cereals or fodder crops. Cato seems to have employed a similar scheme in his description of sheep on an olive plantation (Cato *Agr.* 10, 30; White 1970a: 304, 310). Numerous strategies such as using local scrubland and deserted land as emergency pasture, or cultivating fodder crops, or providing flocks with other feeds such as leaves and grape dregs could enable the farmer to keep his animals on the farm all year round. The costs of raising flocks would be kept low by exploiting land for grazing that is relatively unproductive and remote, or during a period when agricultural land is fallow (Barker and Grant 1991: 77). Flocks would also require adequate drinking water. Amounts would certainly vary depending on factors such as access to a stream or spring, annual rainfall, or cistern and reservoir storage capacities (Thomas and Grabbe 1994). The summer dry months may have caused some stress in terms of water availability; however, the greatest resource strain probably came during the winter months, before which sufficient hay, feed, and possibly water for the stalled animals had to be collected and stored.

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[47] Many others also argue for an integrated system of agriculture and animal husbandry in antiquity (e.g., Delano-Smith 1979, Gallant 1991, Garnsey 1988a, Halstead 1987, Osborne 1987, Spurr 1986).

[48] See Spurr (1986) and Boag (1997) for more discussion of crop rotation schemes in Roman Italy and the integration of animals, especially sheep, into these.

[49] On the other hand, some activities were detrimental to agriculture over the long term. Shepherds in Apulia, we are told, burned off the vegetation so that flocks could browse on the fresh shoots (Verg. *G.* 2.303; Pliny *NH* 16.77.208).

Another complex issue which cannot be examined on the basis of zooarchaeological data alone is that of leasing, renting, or sharing flocks. Such contracts did exist, even as early as Cato's age (Cato *Agr.* 149-150), and are discussed elsewhere.[50] The terms of "use" and "usufruct" varied depending on the circumstances. Manure was included in "use" (as was labour in the case of draught animals) while the right of "usufruct" entitled the lessee to other products, such as wool, hair, milk, and offspring, from the animal (Lirb 1993: 276-277). Several references attest to the contractual use of livestock to manure fields (Ulp. *Dig*. 7.8.12.2; Just. *Inst*. 2.5.4).[51]

The ages for sheep and goat breeding stock as reported by the ancient authors are generally confirmed by the zooarchaeological data. Ewes and rams older than two years were allowed to breed (Plin. *NH* 8.72.187-188; Varro *Rust*. 2.2.14), but discontinued normally between five to eight years (Pallad. 8.11). Similar ages were reported for goats (Col. 7.6.3,8; Plin. *NH* 8.76.200). Dental and fusion evidence indicate that most of the sheep/goat which survived beyond one year, lived to older ages, but not normally much beyond six years. In this way, they could be used as breeding stock for a few years, and yield several coats of wool (or goat-hair) as well.

A single ram or wether produces more wool than the ewe (Isager and Skydsgaard 1992: 91), so it is advantageous to raise wethers particularly if wool is the principal commodity exploited. Rams would be much more aggressive and difficult to control. While castrated sheep are referenced several times in the ancient texts, their prevalence cannot be confirmed using the zooarchaeological data. The characteristics of bones and teeth of castrated animals have not been adequately studied, and the two main effects of castration generally quoted are difficult to determine from the present bone samples. Delayed fusion in castrates (Chaplin 1971) is undetectable when the sample consists primarily of adults, all of which have fused epiphyses. Moreover, since fusion rates can vary within a single element, large numbers would be required to detect any patterns. Most sites had too few sheep/goat long bones to constitute significant sample sizes. The other effect of castration, slenderness of bones (Hammond 1932a; Turton 1969: 3), is more influenced by factors such as breed, nutrition, or level of activity, which makes it difficult to isolate for analysis. Varro (*Rust.* 2.2.18) and Pliny (*NH* 8.75.198) state that lambs were castrated after five months of age, but when after this is not known. Castrates are noted at two sites in northern Italy, Colognola and Innichen, and they do predominate over males at both of these. However, females still comprise the majority. The presence of castrates at these two sites indicates that sheep were castrated at earlier ages, since bones would then develop and fuse along these new lines. Sites with a fairly equal balance of male and female sheep and no apparent castrates (e.g., San Giovanni, Stufels-Senoner, Invillino) need not imply the absence of castration. Rather, males may have been castrated at older ages, after the sexual dimorphic features had already been established as female or male, and when most bones were fused. The predominance of female sheep/goat bones amongst some sites (e.g., Gravina, Cozzo Presepe) is the only evidence against males being castrated when fairly old and kept for their wool. Castration may make the bones more female in build if it occurs at an earlier age, but would probably not modify the bones of older animals, if it took place after the animal reached maturity. Thus, if mature sheep were castrated we would expect their bones to have masculine features.

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[50] See De Neeve (1984), Lirb (1993), and Skydsgaard (1974) for more information.

[51] Pasture could also be rented (e.g., Cato *Agr.* 149, Ulp. *Dig*. 33.7.12.8; id. *Dig*. 19.2.19.1; id *Dig*. 19.5.14.3). Barker and Grant (1991: 30) calculate that about 0.2 hectares are required per sheep. Modern rents of pasture take into account the value of manure (Barker and Grant 1991: 73).

While castration is recommended for wool exploitation, it is not advisable for lamb meat production since young ram growth rates are superior to those of wethers (Hammond 1932a&b). This appears to have been the case in antiquity. If we assume that most meat lambs were slaughtered before five months of age then this period would fall prior to the castration time given by Varro (*Rust.* 2.2.18) and Pliny (*NH* 8.75.198).

As far as the various breeds of sheep and goats are concerned, the texts mention more about Tarentine sheep than any other animal breed in Italy. Columella (7.4.3) claims that this breed produced fine wool and were coated or "jacketed" to protect the fleece. They required great maintenance. Columella (7.4.2-3) adds that they were often kept and fed indoors throughout the year (i.e., no transhumance) and that relatively more male Tarentine sheep were to be reared to adulthood than males of other breeds. While the sites of Gravina, Monte Irsi, Cozzo Presepe, and San Biago are situated near Tarentum in southern Italy, Tarentine sheep do not seem to have been raised at them to any significant degree, and for a few reasons. First, female sheep vastly predominate amongst the zooarchaeological remains at Gravina and Cozzo Presepe (no sex data are available for the other sites), which contradicts Columella's (7.4.4) statement that male Tarentine sheep were commonly reared. Second, there is limited stall space amongst all of these sites, and certainly not enough to house a flock of more than a couple dozen individuals. Finally, the extra feed, time and other resources required of Tarentine sheep would be difficult to obtain, especially if cattle were also kept on site, since they too would require great attention and fodder. Thus, it seems more likely that another breed(s) of sheep was raised at these southern Italian sites, with the Apulian and Calabrian (Col. 7.2.3) as probable candidates. The sheep now in southern Apulia are carpet-wool breeds, while the best wool is produced by Apulian Merino sheep, a transhumant breed summering in the mountains of Abruzzi and wintering on the Tavoliere plain of southern Italy (Mason 1967).

The lack of Tarentine sheep in the zooarchaeological record would imply that most of the sheep raised in Roman Italy were of the shaggy-coated type mentioned by Columella

(7.2.5) and Pliny (*NH* 8.72.189). Wool colour and texture, the two features by which the ancient authors best distinguish breeds, unfortunately cannot be reconstructed on the basis of animal bone evidence. Moreover, although there is some patterning in sheep size according to geographic region and time period, as described earlier, there is also considerable overlap in the size ranges, which obscures recognition of specific size and breed correlations.

There is insufficient evidence in both the textual and zooarchaeological record to identify goat breeds. As in the case of sheep, goats breeds were principally recognized on the basis of wool colour and texture by the ancient sources. Varro (*Rust.* 2.3.2) says there is a thick coat variety and a hairless variety, but he does not detail any size, shape, or habitat differences between them. Pliny (*NH* 8.76.202) adds that not all breeds have horns, but he offers no other details. Zooarchaeological data show no significant patterning in terms of the size and shape of bones or horn cores to determine goat breeds. Moreover, considering the relative abundance of sheep bones over those of goats, the faunal database is skewed towards recognizing variation in sheep breeds, which, as outlined above, has yet to yield conclusive evidence.

Finally, according to the textual references, disease seemed to be a major problem for sheep/goat herds in antiquity. Columella (7.5.1-22), Cato (*Agr.* 96.1), Varro (*Rust.* 2.1.24, 2.2.20), Lucretius (6.1235-1237), Juvenal (2.78-79), Horace (*Epist.* 16.61-62), and Virgil (*Ecl.* 1.46-50) all note the impact a number of ailments, specifically contagious diseases, can have on the flock. The zooarchaeological evidence, however, contains only a few abnormal sheep/goat bones. Relatively insignificant, non-contagious, and non life-threatening dental pathological conditions such as calculus and periodontal disease are more common than any post-cranial skeletal abnormality. That the latter is best represented by osteoarthritis on the phalanges indicates normal degenerative disease from old age, and not any contagious ailment. The zooarchaeological evidence, therefore, shows that Roman sheep/goat were fairly healthy, at least in terms of skeletal pathological disorders. However, many diseases will leave no osteological traces, and as such no conclusions can be made about the incidence and prevalence of all diseases amongst the sheep/goat from Roman Italy.

Part 3: PIGS

Zooarchaeological Data

Identification and Quantification

Pig bones were recovered from all of the rural sites and urban sites, and about 75% of the special sites. Overall the NISP and MNI patterns for pigs do not vary remarkably, despite a couple of circumstances where individual values are separated by relatively large percentage margins.

Figure 21 shows the calculated mean values of the various NISP and MNI frequencies for pigs according to site type, while Table 41 lists the range, variance, standard deviation, and sample size for these. Only sites with total NISP and total MNI values of 100 and 10, respectively, have been used in these calculations.

As in the case of the cattle and sheep/goat analyses, there is some variation in the mean NISP and MNI frequencies for pig depending on which site type category is considered. With pigs, however, the greatest discrepancy between these values occurs at rural and urban1 sites, while it is at special sites among cattle and sheep/goat. On average, over half of the mammalian NISP at urban1 sites are pigs, with rural sites posting NISP mean frequencies just over 40%. These figures are up to double their urban2 and special site equivalents. The differences amongst site types, however, are less pronounced when MNI values are examined, but the ordinal ranking remains essentially unchanged. Urban1 sites still contain the greatest mean frequency of pigs on the basis of MNI figures, and are followed by rural sites, special sites, and urban2 sites in decreasing order.

Figure 22 shows the mean relative frequency of pig remains calculated on the basis of NISP and MNI values, but with the data broken down into geographic region/time period/site-type clusters. Special sites are not included in Figure 22. Only sites with NISP grand totals greater than 100, and MNI grand totals greater than 10 are included.

One overall difference between the pig graph (Figure 22) and those for cattle (Figure 12) and sheep/goat (Figure 20) is in the amount of discrepancy between NISP and MNI values within a single region/time period/site type grouping. Less than five percentage points separates the majority of cattle and sheep/goat NISP and MNI pairs, although there are a few groups with blatantly excessive differences (e.g., cattle: N/1/u2, N/3/u2; sheep/goat: S/1/r, C/1/u1, N/2,3/u2). For pigs, however, a spread of over 10 percentage points separates many of the paired NISP and MNI figures. In many of these cases, NISP frequency values exceed their corresponding MNI values.[52]

Both NISP and MNI mean frequencies for pigs increase significantly amongst rural sites in south Italy moving from earlier periods to later periods. Southern Italy, in fact, shows the greatest change in these values, although the Imperial and Late Antique data values for pig are based on only two sites (San Giovanni and San Biagio) which may not be indicative of the overall pattern. While pigs contribute relatively little to the economy and diet of southern Italy during Republican times, they predominate during Late Antiquity.

Central and northern Italy display less temporal variation than southern Italy in terms of mean NISP and MNI pig frequencies. The overall frequency of pigs at rural sites in central Italy remains fairly constant over time; NISP and MNI values cluster near 30% and 40% respectively. Imperial period sites in central Italy, however, record slightly more pigs than sites of either Republican times or Late Antiquity in the same area. This difference is most pronounced at C/2/u1 sites where pigs account for over half the NISP and MNI frequencies - the greatest of all region/time period/site type categories listed. Pig frequency values at both types of urban sites in central Italy are usually a few, up to ten, percentage points higher than their rural counterparts.

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[52] The augmented discrepancy between NISP and MNI frequencies for the pig compared to cattle and sheep/goat is certainly, in some part, due to the fact that there are more bones in the pig skeleton, and thus potentially more NISP to count.

There are less data available for sites in northern Italy, but what are obtainable show a slight increase in the frequency of pig bones over time, at least amongst urban2 sites. Frequencies remain fairly stable at c. 25% (NISP) and c. 30% (MNI) during both the Republican and Imperial periods, before rising about ten percentage points to c. 35% (NISP) and c. 40% (MNI) during Late Antiquity. Urban1 sites consistently register more pigs than their urban2 counterparts, while the limited data on rural sites in the north show that pigs were somewhat plentiful there as well.

Age

Table 41 gives a summary of the fusion data for pigs; the complete data are listed in Appendix 9. The data in Table 41 are arranged according to site type. Values indicate the mean frequency of bones with unfused epiphyses, as similarly calculated in the cattle (Table 21) and sheep/goat (Table 34) fusion analyses.

Table 43 presents the mean frequency and range of pigs at various ages calculated on the basis of dental data. The complete list of all individual sites including information on which method(s) for dental aging was used is given in Appendix 10.

Finally, Appendix 11 provides comments made by researchers about the relative frequency of pig bones at various age stages such as juvenile, subadult, adult, old age, and so forth. In some cases numeric percentages are given, while in other cases this is expressed as some relative term (e.g., "many," "most," "few," etc.).

The often expansive spread between the minimum and maximum frequency values at each age category/site type pairing as given in Tables 42 and 43 highlights the fact that there will always be individual variation amongst sites which may otherwise be contemporaneous and share the same site-type designation and geographic location. A general analysis using mean values helps identify data trends but masks much of the individual variation. Thus, caution is always required in interpreting mean frequencies. Sample sizes for pigs are larger than those for the cattle aging analysis, and roughly the same as those for the sheep/goat analysis, but still below ten sites for most categories. The general pig kill-off pattern, however, is different than its cattle or sheep/goat counterpart. Inspection of Tables 42 and 43 and Appendices 9 - 11 reveals that nearly all pigs were killed at younger ages, usually before three years of age. This pattern is consistent amongst all site types (and geographic area and temporal period as well, although the data for these are not shown). According to the fusion data, an average of c. 85% of pigs had unfused epiphyses in the 31-35+ month category at rural and urban1 sites. In other words, only about 15% survived beyond three years. This contrasts with figures for cattle and sheep/goat, which register between 50 and 80% survival beyond three years. There was certainly no economic value in keeping older pigs during Roman times in Italy. The pig dental data complement the fusion data in that few individuals survive to elderly ages; however, the dental statistics among site types show more variation. Rural sites, for example, register an average of about 20% of pigs which lived beyond 24 months, while urban2 and urban1 sites report mean values of c. 30% and c. 40%, respectively, for the same age bracket. This marked discrepancy between the fusion and dental data amongst urban1 sites in particular lends support to the hypothesis that Roman cities received more cuts of pork (or had unique taphonomic conditions). Had whole pigs been interred at these sites, then one would expect a more positive correlation between the dental and fusion data. Special sites report the reverse conditions to urban1 sites. Here, far fewer older pigs are accounted for in the dental data than are suggested by the fusion data. Such a discordant pattern again suggests differential internment of pig skeletal parts.

Pigs under about one year of age are frequently represented amongst rural sites. Fusion data report that c. 47% of pigs were less than eleven months while corresponding dental data indicate c. 32% fall into this age category. Urban1 sites register a mean frequency of c. 26% of pigs under a year on the basis of fusion data, but their dental equivalent is c. 31%. There are insufficient fusion data for urban2 sites to draw comparisons with dental results. The presence of fetal and newborn piglets at rural sites suggests that most births occurred at country villas and farms, an expected event. However, comparatively more pigs in the 3-6 month age bracket were consumed at urban sites than in rural areas, suggesting some import of sucklings.

According to the dental data, about half of all pigs killed and consumed at rural sites died between one and two years of age, leaving only about 20% to survive into their third year (and be consumed on site). Amongst urban1 and urban2 sites, however, the age bracket for these subadult deaths is broadened. Over half of the pigs at both types of urban sites died between approximately one and 2.5 years of age. Moreover, a further 20% of deaths is noted in the 30+ month category at urban1 sites. Urban sites, especially the large cities, seem to have consumed more older pigs (approximately six months to one year older) than did their rural counterparts.

Pig age patterns amongst the special sites require individual attention. A mix of ages is noted at the cemetery of Cantone, but most of the pigs in the Lugnano cemetery are juveniles and subadults. Very young and fetal pigs predominate in the ritual/sacrificial deposit at San Omobono, but Campochiaro, another ritual deposit, has relatively fewer juvenile pigs by comparison. Older pigs appear in the well deposit at Lipari,[53] but young and fetal pigs are better represented in the well at Vaste. These contrasts highlight the fact that there is no set pattern in pig ages amongst special sites.

Age statistics for sites with pig fusion and dental sample sizes of less than ten specimens generally conform to the patterns outlined above. Very few elderly pigs, older than three years, are noted amongst any of these sites. Most record a mix of juvenile, subadult, and early adult pigs. Pigs less than two years dominate at rural sites, with a fairly equal proportion of deaths at each of the following age groups: 0-6 months, 6-12 months, 12-18 months, and 18-24 months. Juvenile and subadult pigs predominate amongst urban sites with fusion and dental sample sizes less than ten. Overall, fewer adult pigs are reported than at rural sites, with most of these urban1 examples with older pigs located in northern Italy. The pig age pattern at those urban2 sites with smaller sample sizes resembles the rural distribution, with a mix of all ages, but principally subadults and early adults.

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[53] Lipari is an island off the north coast of Sicily. Since the site is removed from peninsular Italy, it is not considered in this thesis. The late Iron Age and Hellenistic pigs recovered from a well at this site are only used in this context as a comparison with Vaste. On the faunal material from Lipari, see Villari (1991).

Seasonality

Any seasonal pattern of pig breeding and slaughter as recognized in the osteological aging data is complicated by the fact that pigs can breed twice a year. A pig is pregnant for four months, can suckle newborns in the following two months, and then be ready to breed again. The pattern repeats in six month cycles, which is the same interval that separates nearly all of the dental age groups shown in Table 43 and Appendix 10. More specific age groups are required to pinpoint seasonal slaughtering trends. Nevertheless, some information about slaughtering schedules can still be gleaned from the available pig age data. According to the dental data shown in Table 43 the first major kill of pigs occurs in the 3-6 month age group for all site types, especially urban2 sites. If we assume a preference for early spring mating in pigs resulting in summer births—the natural tendency in many animals and the common practice for pigs according to the ancient sources (Varro *Rust.* 2.4.7, 2.4.13; Col. 7.9.3)—then this first major slaughter would occur in the late autumn/early winter months (November to January). At this time, 15-18 month pigs born the previous summer could be culled, alongside 27-30 month pigs born two summers ago. Thus, we would expect a preponderance of deaths in the 3-6 month, 12-18 month and 24+ month category in the dental data. That none of the mean values in Table 43 displays this pattern perfectly, discredits the universal acceptance of the scheme outlined above. Urban2 sites may have practiced this annual summer birth/winter cull pattern to a greater degree than other sites types, since high mean values are noted in the 3-6 month, and 24+ month categories. Of all the individual sites listed in Appendix 10, Populonia conforms rigidly to this pattern, while Settefinestre, Stufels, Monte Barro, and Invillino follow it less strictly.

If pigs bred twice a year, but were culled annually, then we would not expect to see any significant peaks in the age data, even if the breeding times were carefully restricted to certain months. Again, if we assume a late autumn/early winter cull then 3-6 month individuals born in the summer could be killed alongside 6-12 month individuals born during the previous winter. Working back in six month intervals gives us a population of 12-18 month pigs (i.e., born the previous summer), 18-24 month pigs (i.e., born the previous winter), 24+ month pigs (i.e., born two summers prior), etc., which would be potentially available for slaughter at this time. In other words, every age group would be represented. Moreover, in this scenario we might expect deaths in the fetal and newborn category since culling would co-occur with the arrival of the newly delivered winter-born pigs, some of which may have been killed immediately. The relative closeness of individual values to one another as shown in Table 43, especially in the 6-12 month, 12-18 month, and 18-24 month categories reveals that this scheme of biannual breeding and annual culling may have been more commonly practiced in Roman Italy. Rural sites in general tend to conform to it, with Matrice, Via Gabina, Monte Irsi, Gravina, and San Giovanni as some of the better (although never perfect) examples.

Sex

Table 44 lists the number of pig bones for which sex was determined, and the frequency of males and females. The pig canine tooth is sexually dimorphic. Males have larger, and longer canines than females. The difference is readily distinguishable and the test fairly easy compared to sex determination in other animals, hence the greater number of sites with information about the sex of pigs.

The data reveal several trends. First, male pigs outnumber females at nearly every site. In most cases, males account for between 60% and 80% of the sexed canines. At no site, even those with very small sample sizes, do males tally less than 25%. A second point is that, on average, males are more frequent amongst urban1 and urban2 site than at rural sites. Third, although male pigs predominate overall, sites in northern Italy consistently claim high percentages of male pigs. Central Italy also registers fairly high figures for males, while, on average, sites in southern Italy yield the lowest. Finally, the data indicate that male pigs become even more abundant over time. There are, on average, about 60% males and 40% females amongst Period 1 sites. The value for males drops slightly to around 55% (with 45% females) during Period 2, but climbs notably to approximately 70% males (30% females) during Period 3. This change is dramatically displayed at all individual sites which span two or more time periods. The frequency of male pigs at Settefinestre, Carminiello, and Matrice jumps from c. 55-60% in Periods 1 or 2 to over 80% in Period 3, while the number of male pigs at San Giovanni nearly doubles in Period 3 (55.4%) from Period 2 (28.6%).

Age and Sex Correlation

While the correlation of age and sex data in pigs carries the same problems as that in cattle and sheep/goat in the case of comparing dental and fusion data, the procedure is potentially simplified when using the dental data solely. Pig canine teeth are dimorphic. Moreover, pig teeth provide better aging evidence that those of cattle or sheep/goat in that eruption and wear sequences have been established for fairly tight age clusters, usually about six months apart as shown in Table 43. The best procedure would be to establish an aging scheme for the canine tooth, in both its deciduous and permanent form, along the lines of that developed in the analysis of pig remains at the site of San Giovanni (MacKinnon, in press). This provides the greatest control, because both age and sex data would be obtained from the same source—the canine tooth—as opposed to age data principally taken from molar teeth eruption and wear patterns, and sex from the canine.

Although the potential exists for good control in pig age and sex correlation, complications arise for the present analysis, which require assumptions to be made. First, the composition of the sexed sample was not always revealed amongst the reports used, and it is not known to what extent deciduous teeth were included. Suppose, for example, a site reported a fairly equal balance between ages and sexes. In the absence of the sample composition, this could be interpreted as 50% young males and 50% older females, or 25% young males, 25% young females, 25% older males, and 25% older females—two entirely different schemes. I assume, therefore, that pig sex ratios are principally based on counts of the permanent canine teeth, since they are larger and survive better in the archaeological record than their deciduous equivalents. The permanent canine tooth erupts at an age of around eight to twelve months in the pig (Silver 1969), and would certainly be visible and in wear by one year of age. My second assumption is based on the premise that young male pigs are more expendable than young females. I assume this applies to all sites, and therefore ascribe a male sex to the majority of young individuals as shown in the dental aging data. This predisposes the young female category to register few occurrences (since many of these would be spared slaughter) while simultaneously augmenting the older female tallies (since these young females would survive to older ages before being killed).

Table 45 attempts to relate the information on pig age and sex. Four broad categories are recognized: young males, older males, young females, and older females. The combined dental categories fetal/newborn, 1-3 months, 3-6 months, and 6-12 months constitute "young," while those above twelve months are labeled as "older." The fusion category "<11 months" denotes "young," with all others used to get a sense of "older" pigs. The relative frequency of each category is denoted by a range of "•," with no "•" (i.e., blank space in column) meaning total absence, and "••••" indicating a great abundance.

Given the assumptions made, it is expected that young males and older female pigs predominate amongst the sites listed in Table 45. What is more important from this exercise is the degree to which this occurs, and the relationship amongst sites. Most of the rural sites listed in Table 45, at least those with larger sample sizes, record pigs in all four age/sex categories (i.e., young males, older males, young females, older females). Fairly equal representation amongst these categories—as at Gravina, Cozzo Presepe, or Matrice-period 2—implies a more natural herd of pigs, perhaps subject to some human intervention in terms of breeding. As soon as the relative proportions begin to change, however, the size of the herd and the degree to which humans intervened in its demography surely increases. Thus, the data from Table 45 suggests that sites such as Settefinestre, San Giovanni, Matrice-period 3, and Monte Barro are more likely candidates for large-scale pig-raising operations which required stricter demographic control. A similar argument can be made for urban2 sites, with Stufels, Altino, and Colognola as examples. The few urban1 sites listed in Table 45 show basically the same pattern as rural and urban2 sites. However, Carminiello and Pompeii-Ganimede register a sizable proportion of older male pigs compared to the other age/sex groups and sites.

Size

Table 46 lists the withers height range, mean, variance, standard deviation, sample size and composition for pigs. Teichert's (1969) coefficients have been used throughout. Although Teichert (1969) does provide factors for the 3rd and 4th metacarpals and metatarsals (bones which frequently preserve complete) I have not applied them here. Tests by von den Driesch and Böessneck (1974) show these factors to be unreliable, often leading to withers height estimates which are too high. Table 46 is organized according to geographic region and time period.

Even without the addition of pig metapodials, a review of the sample composition reveals that far fewer pig long bones survived in a complete state relative to those of cattle or sheep/goat. A single femur is the only pig long bone for which a GL measurement is recorded. The vast majority of measures used in this withers height estimation come from the astragalus, which, although adequate, is not really the best bone to use, for reasons noted above (in the sheep/goat analysis). Nevertheless, the data from Table 46 do not show any regular pattern of size increase in pigs over time as those from Tables 26 and 38 indicate for cattle and sheep/goat respectively. A notable increase in mean withers height of the pig occurs between Republican and Imperial times in central Italy, but this declines into Late Antiquity in the same region. A reverse pattern is shown in northern Italy (i.e., decline then increase), but the difference amongst these three means is so slight as to be insignificant. Likewise in southern Italy the difference between the average values for Periods 1 and 3 is just over 1 cm, while here too the data indicate a slight decrease in withers height over time.

The pig withers height ranges generally lie below a 19 cm spread, but Imperial and Late Antique sites in central Italy tally closer to 27 cm. Combined, these latter groups contain the two smallest and the two largest pigs of all other region-time period clusters. Moreover, the larger pigs at these sites are at least 3 cm greater than their nearest counterpart; in the majority of cases they are more than 10 cm taller at the withers. The discrepancy is much too marked to be explained by sexual size dimorphism. It is possible that some of the larger individuals are wild boars that had not been separated from the domestic pig category during the faunal analysis. Although there is always variation, wild boars generally attain withers heights of over 80 cm;[54] therefore, it is possible the 85.5 cm and 84.1 cm examples from C/2 and C/3 contexts are wild boars. However, it is also possible that different domestic pig breeds—small ones and larger ones—existed in central Italy during these times. Excluding the two wild boar suspect values from C/2 and C/3 contexts still leaves the greatest withers height span (i.e., from c. 57 cm to nearly 80 cm) of all region/temporal periods groups. This spread of c. 23 cm is large enough that it might encompass two breeds of pigs. If this is the case then there may have been a greater variety of pig breeding schemes practiced in central Italy during the Imperial and Late Antique periods, as opposed to concurrent times in southern and northern Italy, or anywhere in Italy during the Republic.

Abnormalities

Table 47 lists the incidence of various categories of skeletal pathologies for those Roman period sites in Italy which provided such information. Table 48 provides a similar count for dental elements exclusively. The sites are organized according to geographic region, time period, and site type. The various temporal phases of some sites which span several time periods (e.g., Settefinestre, San Giovanni, Monte Gelato) have been combined in this analysis. The reports did not always distinguish pathologies by time period and often grouped them together for discussion.

Although pig skeletal abnormalities from Roman period sites in Italy occur with greater variety and frequency compared to those of cattle or sheep/goat, there are still too few examples to conclude that pigs were in anything but generally good health. Dental pathological conditions predominate, which is not surprising considering pig teeth were common finds at most sites. Dental caries, or cavities, ranks as the least frequent pathological condition, while calculus, periodontal disease, tooth infection, and abcess development are more commonly represented. Crowding and twisting of teeth, as well as ante-mortem tooth loss can lead to abnormal wear. Although not as prevalent as calculus and associated abnormalities, such ailments, and especially dental crowding, often help indicate domestication, while tooth loss and abnormal wear inform us about the survival of individual animals under handicapped, and often very painful conditions.

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[54] The withers height estimate of the smallest adult wild boar recorded in Payne and Bull (1988) is 79.8 cm (based on GL measure of 44.6 from an astragalus of a 19-23 month individual from north-central Turkey).

Several non-dental abnormalities of pig bones are noted in Table 48. Several healed fractures and a couple of cases of infection are reported, with the pig metapodials as the principal element affected by these injuries and ailments. In contrast to the reported pathological conditions for cattle and sheep/goat, arthritic bone and its associated symptoms is very rare amongst pigs. Only a single case is accounted. We would expect such degenerative ailments to be scarce, considering that most pigs in Roman Italy were killed before attaining elderly ages, and in light of the fact that they were not used as draft animals (as were many cattle), or involved in any type of transhumance (as were many sheep and goats).

Textual Data

Pigs were common animals on most Roman farms. "...Who of our people runs a farm without keeping swine?" (Varro *Rust.* 2.4.3). They could adapt to almost any sort of environment, live off of scraps and refuse, and find suitable pasture both in the mountains and the plains (Col. 7.9.6). Furthermore, since pork was the preferred meat in the Roman diet, there existed a constant demand for pigs. Aside from their edible products, pigs contributed few other resources to the Roman economy, all of which were generally insignificant. Their manure rated poorly relative to that of other animals (Col. 2.14.1; Varro *Rust.* 1.38.3), while there is little mention of use of pig hides or skins for clothing or other goods. Grattius (*Cyn.* 339) mentions that pig skin is used as part of the hunting ensemble, but he is not specific as to clothing or other equipment.

The Roman agricultural writers discuss husbandry schemes and principles used to exploit the full potential of pigs. Two levels of operation are apparent. At one level, a pig or small group of pigs can be kept around the farm to feed off scraps and litter (Plin. *NH* 8.77.206). Alternatively, large-scale breeding operations to supply the market demand for pork can be practiced. The agronomists, particularly Varro and Columella, devote considerable attention to the latter practice which can potentially bring much profit to the farmer.

Two kinds of pigs are described. The dominant type, ubiquitous throughout Italy, was similar in appearance to the wild boar, with hard dense, black bristles (Col. 7.9.2; Pallad. 3.152; Lucr. 5.969-970). Smooth pigs and even white ones (Petron. *Sat.* 47; Juv. 13.117-118), however, may also be pastured in warmer and sunnier regions (Col. 7.9.2). The latter type was frequently kept by bakers and fed off the excess supplies of bran (Col. 7.9.3).

According to Columella (7.9.1), the best boars for breeding are those renowned for their great size and huge haunches, but not for correspondingly long legs and hoofs. Palladius (3.151) adds that they should be great-bodied, ample and round, with large hips and white bellies. Boars are fit for breeding from a year until they are four years (Col. 7.9.2). Pliny (*NH* 8.77.206) limits them to breeding between one and three years, while Varro (*Rust.* 2.4.8) has them beginning at eight months. As with sheep and goats, boars were to be removed from the sows two months prior to mating and then again after the females had conceived (Varro *Rust.* 2.1.18, 2.4.7-8). Sows, on the other hand, should be large-bodied and pendent (Pallad. 3.152), but also long in shape (Col. 7.9.2). They should not breed if under a year old (Varro *Rust.* 2.4.7); however, it is better to wait until twenty months, so that after their four month gestation period (Varro *Rust.* 2.1.19) they will be two years old when they first bear (Varro *Rust.* 2.4.7; Pallad. 3.153). From this point on a sow can bear two litters a year until about seven years (Varro *Rust.* 2.4.14; Col. 7.9.3), following a pattern of four months pregnant, two months to suckle newborns (Varro *Rust.* 2.4.14). However, such a rigorous birthing schedule was not always advised. Newborns born in the winter months did not normally fare well under the cooler conditions, and at a time when the mother's milk was apparently of poorer quality (Varro *Rust.* 2.4.13). Summer litters (i.e., mating in February) were preferred (Varro *Rust.* 2.4.7, 2.4.13; Col. 7.9.3). Litters up to twenty have been recorded (Plin. *NH* 8.77.205), but the number was usually checked to prevent the sow from exhausting her milk supply too soon and becoming weak. Varro (*Rust.* 2.4.19) recommends limiting the litter to eight piglets as the normal number; Palladius (3.156) more cautiously suggests six. According to Pliny (*NH* 8.77.206) a sow could live to 15-20 years, but none of the authors give life-expectancy figures for the boar.

Swineherds were to keep a close eye on the sows and put pregnant and farrowing individuals into sties (Col. 7.9.11; Varro *Rust.* 2.4.13). Pigs were not to be shut up together, like all other animals, but placed in individual sties (Col. 7.9.10). Each should be about four feet high, wider than long, unroofed, and may include a door (Varro *Rust.* 2.4.14; Col. 7.9.10), although Columella (7.9.13) ignores the latter stating that sows can climb over walls which are not too high. Clean sties diminished disease (Col. 7.9.14). Juvenal (2.78-79) warns that an epidemic of mange can destroy a whole herd of pigs, while Plautus (*Trin.* 2.4.539-540) recounts how an attack of "quinsy" killed a group of swine. To ensure sanitary conditions, legislation prohibited water which passed through pig sties from continuing on to a neighbour's land (Ulp. *Dig.* 39.3.1.15).

The size of the pig herd varied considerably. Cato (*Agr.* 10.1, 2) includes a swineherd in his lists but gives no numbers. Varro (*Rust.* 2.4.22) states 100 is reasonable, but mentions that some herders keep 150, 200, 300 or more. Basically, the breeder determines the size of the herd by his own advantage (Varro *Rust.* 2.4.22). However, Varro (*Rust.* 2.4.22) cautions that a rather small herd is relatively less expensive than one too large, as the latter requires more helpers to control the herd. In terms of sex ratios, ten boars for every 100 sows suffice; some farmers keep even fewer males (Varro *Rust.* 2.4.22).

Although pigs can feed on practically anything, their most convenient feeding-grounds are woods covered with oaks, beeches, and other deciduous trees (Col. 7.9.6; Ulp. *Dig.*

19.5.14.3). Forests with a range of tree species which ripen at different times of the year provide an abundant annual supply of food (Col. 7.9.6), as well as an excellent place for a pig to scratch its ribs (Lucil. 9.356). Acorns appear to be the dominant food source (Mart. 11.41; Ael. *NA* 8.9; Ulp. *Dig.* 19.5.14.3, 39.3.1.15; Strab. 5.1.12), at least during the late autumn and early winter months (Verg. *G.* 2.520; Macrob. *Sat.* 1.21.4; Mart. 14.71). Where forests are sparse, pigs can be fed on fodder crops, fruits, roots, barley, beans, grains, or other plant materials (Varro *Rust.* 2.1.17, 2.4.6; Col. 7.9.7-9), and even bird dung (Varro *Rust.* 1.38.2). Varro (*Rust.* 2.4.3) and Pliny (*NH* 8.209) note how pork acquired different flavours depending on the diet of the pig. In summer, herds are driven to pasture early in the day, to shaded areas in the afternoon, and back to pastures later in the day (Varro *Rust.* 2.4.6). In winter they are not driven out until mid-morning when the frost and ice have melted (Varro *Rust.* 2.4.6). Columella (7.9.9) recommends even feeding them before they go to pasture. It is unknown how far pigs were herded, but Varro (*Rust.* 1.13.3) does mention that they can drink from the water reservoir at the farmstead when they return from pasture, thus giving the impression that they remained fairly close to the farm if they were returning to it daily. Apparently measures were taken to keep good control over them while they pastured. Although young pigs often followed their mothers to pasture (Varro *Rust.* 2.4.20), swineherds should accustom their pigs to do everything to the sound of a horn, so they would not become lost when scattered in the forests (Varro *Rust.* 2.4.20). Pliny (*NH* 8.77.208) adds that some pigs are trained to lead others to the market, and then return home. He also, in a somewhat fantastic account, claims that some pigs carried off by thieves (note that Ulp. *Dig.* 47.8.2 states that rustling was a matter of concern for all animals, including swine) recognized the voice of the swineherd, crowded to one side of the getaway ship until it capsized and sank, and swam back to shore (Plin. *NH* 8.77.208; Ael. *NA* 8.19, also recounts this tale). Thus, it appears that herding pigs was not as difficult in Roman times as we might expect, considering the controlling techniques used (e.g., training pigs to follow others, and respond to a horn). Mistakes and misfortunes still happened, however. Ovid (*Fast.* 1.351-352) tells how unchecked swine rooted through and destroyed a field of grain, while the Digest states that the threat of wolves on the pig herd could be countered with guard dogs (Ulp. *Dig.* 41.1.44).

Considering the value and versatility of pig meat it is no wonder that the ancient authors devote considerable attention to the breeding of this animal. Columella (7.9.4) outlines a breeding scheme for sucking-pig production wherein sows conceive twice a year. Their litters were fattened quickly and sold at the market, which, apparently was not too far from the farm (contra. Col. 7.9.3). Both Columella (7.9.4) and Palladius (3.153) note that if you eat or sell the piglets, the mother will soon breed again. Sucklings were considered pure on the tenth day after birth (Varro *Rust.* 2.4.16), but could be offered for sacrifice at only four days old (Plin. *NH* 8.77.206). Sixty days of weaning was enough to fully fatten a suckling (Plin. *NH* 8.77.207).

A different technique, centering around the production of good stock, was employed for farms without easy access to urban markets (Col. 7.9.3). In this scheme annual litters are suggested, which should be born in July when the sow has plenty of milk and much food is available (Col. 7.9.3). Here, mature animals provide most of the meat. According to

Varro (*Rust.* 2.4.8), boars deteriorate after three years of age and should be butchered before this time. Columella (7.9.4) notes that males were castrated so they might be enabled to grow fat, either at six months, or else at three or four years, when they have been often used for breeding. He recognizes two seasons, spring and autumn (Col. 7.11.1), for this procedure. Varro (*Rust.* 2.4.21) adds that pigs are better castrated when one year old. Fat rather than lean pigs were the preferred food-fare (Varro *Rust.* 2.4.4, 2.4.12; Juv. 13.117-118; Prop. 4.1a.21-24; Macr. *Sat.* 5.11.23).

Demand for pork was high during the Roman period, throughout the empire. Both young and old pigs were required for sacrifices, while armies and families consumed great amounts of fresh and preserved meat. The Roman authors name several regions which were key centers of production for pigs or pork products, including areas of Gaul, Spain, and the northern fringes of the Roman empire. Overall, Italy appears to have been less productive, but several important areas are mentioned. Cato (cited in Varro *Rust.* 2.4.11) claims that, outside of Gaul, the best and largest hams and shoulders of pork come from the district around Milan, which boasted of exporting three or four thousand salted flitches annually. The Greek authors Strabo (5.1.12) and Polybius (2.15) echo the importance of Cisalpine Gaul in providing pigs for Rome. Other significant pig and pork producing areas of Italy included the regions of Campania, Samnium, Bruttium, and Lucania. According to the Theodosian Code (*CTh* 14.4.10.3) and references in Cassiodorus (*Var.* 11.39) these regions (especially Lucania) were heavily taxed in kind for pigs and pork - over 3000 tons worth per year. Moreover, Lucania was particularly famous for its sausages (Apic. 2.4).

Lastly, while there is much documentation about raising pigs in rural districts there is inconclusive textual evidence about keeping them in urban areas during Roman times. Plautus (*Capt.* 4.1.807-808) complains that the pigs which the millers keep to feed off the milling waste raise such a stench that no one can go to the mill. He does not disclose the whereabouts of these mills but an urban or at least popular context is implied judging by the reference to (many?) people visiting the mill. Horace (*Epist.* 2.2.72-75) mentions a mud-spattered sow rushing down the street in a description of the hustle and bustle that can occur in the city, presumably Rome in this context.

Integration

The textual references and zooarchaeological data about pigs in Roman Italy show much correlation. Varro's (*Rust.* 2.4.3) comment about their ubiquity certainly holds true when we consider that pigs bones were found at nearly every site used in this analysis. Pig NISP and MNI values often surpass those of all other animals at a site. Overall, pigs account for, on average, c. 33-43% of the total NISP and MNI mammalian frequencies at rural sites, c. 40-54% at urban1 sites, and c. 25-30% at urban2 sites. Sites in central, and to some extent northern Italy consistently record high percentages of pig bones, throughout each of the three temporal periods recognized, while pig frequencies among sites in southern Italy significantly increase over time. Columella (7.9.6) notes that pigs could adapt to a wide variety of environments and find suitable pasture almost anywhere, and their zooarchaeological presence at sites in different geographic regions of Italy, from mountains to plains, verifies this.

2

The texts mention several regions of Italy which were considered important pig producing areas. Parts of northern Italy such as Cisalpine Gaul and the district around Milan are specified by Republican and Imperial period authors such as Strabo (5.1.12), Polybius (2.15), and Cato (cited in Varro *Rust.* 2.4.11), while the regions of Campania, Samnium, Bruttium, and Lucania (i.e., south-west central Italy and western southern Italy) are noted by Cassiodorus (*Var.* 11.39) and the Theodosian Code (14.4.10.3) as zones which were heavily taxed for pigs and pork during Late Antiquity. The zooarchaeological data concur to some extent. The importance of northern Italy in pork production is supported by high pig NISP and MNI frequencies at sites such as Palazzo Dugentesco, Lomello, and especially Monte Barro, all of which, more or less, are situated near Milan. However, no consistent pattern forms for other areas of northern Italy. Alpine sites such as Innichen, Stufels, and Invillino, although technically part of Cisalpine Gaul, register pig NISP frequencies as low as c. 9% to a moderate c. 30%, hardly what might be expected in an intensive pig-rearing scheme. Sites along or near the northern Adriatic coast (e.g., Spina, Pozzuolo del Friuli, Torcello, Altino) tend to hold slightly higher pig NISP frequencies than their Alpine neighbours. Overall, however, pigs are important to the diet and economy of northern Italy.

Pigs figure much less prominently in rural and urban2 faunal deposits from southern Italy, with one major exception: San Giovanni. The Late Antique deposits at this site record the greatest NISP and MNI frequency of pigs for all rural and settlement sites in the whole of Roman Italy. This conforms well with textual references about taxing areas of southern Italy, particularly Lucania (where San Giovanni is located), for pigs.

Apart from mentioning Campania and Samnium as regions taxed for pigs during Late Antiquity, the ancient sources provide no details about the incidence or prevalence of pig husbandry in other parts of central Italy. No specific areas here are cited as prime pig producing zones. NISP frequencies, however, show that pigs predominate at c. 90% of the sites in the area. In many of these cases the pig NISP values are double, triple, even quadruple and more times greater than those of the second ranking mammalian taxon (usually sheep/goat or cattle; see Table 16). As in northern Italy, there is no consistent pattern for these sites of central Italy. Rural sites in Etruria (e.g., Settefinestre, Le Colonne, Monte Gelato, San Giovenale) register similar pig frequencies to those in eastern central Italy (e.g., Matrice, San Potito) as well as those around Rome (Via Gabina, Quintili). Moreover, there is no patterning in terms of environment or terrain, with pig percentages high among hilly, wooded, montane, and lowland zones.

The similarity in the lower range of the pig withers height values in Table 46 suggests that a single breed of pig was kept throughout Italy. On the basis of zooarchaeological data I propose this breed averaged between c. 60 and c. 75 cm in height at the shoulders. A marked bimodal distribution for pig withers height measurements (not attributed to sexual size differences) for Imperial and Late Antique sites in central Italy, however, is good evidence for the existence of a second pig breed, with a withers height in the c. 75 to c. 85 cm range. The ancient authors describe two types of pigs: a bristled, smaller, darker breed and a smoother, larger, white-pink breed. The zooarchaeological data agree with the textual references that the dominant type was the smaller one. This breed is thinner and leaner than the large, white and pinkish breeds common to us today. It probably resembled the wild boar in being a darker-skinned, bristled beast,[55] but was perhaps half its size (Clutton-Brock 1981: 74). The larger breed is a more likely candidate for a stall fed variety which was not herded but rather raised and fattened in a fairly controlled environment. The type kept by bakers and mentioned by Columella (7.9.3) was probably a larger breed of pig. In fact, I would suspect that many of the individual pigs raised in urban settings were bigger breeds. These would be better suited to consume refuse which accumulated in the city. Their massive size and weight probably made them less agile and less mobile than smaller breeds, and were qualities likely favoured by urban dwellers who did not wish to chase any pigs which had escaped. Furthermore, when it finally came to consuming them, these fat pigs would provide excellent tender meat, compared to leaner, smaller breeds.

The fluctuations in the mean withers heights for pigs over time, but within the same geographic area, may in part be related to different herding schemes. The decrease in average pig size from Republican to Late Antique times in southern Italy might be explained by the fact that the sites comprising each of these groups are in different environmental zones, and each probably raised pigs in a different manner. Republican period sites like Gravina, Monte Irsi, and Locri (which comprise the S-1 sample in Table 46) likely kept only a limited number of pigs around the farm, maybe even some smaller white ones, although available data cannot confirm this. These pigs were probably pastured, as outlined by Columella (7.9.2,9), and fed fodder so that they may grow fat. With smaller numbers, feeding (and breeding) could be better controlled, and larger pigs encouraged.

The Late Antique sample of pig measurements comes from the site of San Giovanni, located in the Lucanian Apennines. Research here indicates that a large herd of pigs was kept but in a more casual fashion than at other rural sites in the south (MacKinnon, in press). Pigs at San Giovanni were probably not stalled at the farm and presumably not pastured in nearby fields and on fodder in a fairly strict fashion. Rather they foraged, somewhat freely, in the local forests. The ancient sources concur that the most convenient feeding-grounds for pigs are deciduous woodlands (Col. 7.9.6; Mart. 11.41; Ulp. *Dig.* 19.5.14.3; Strab. 5.1.12). The tighter range in withers height measurements, which lie at the lower end compared to other sites, suggests that only the smaller, dark breed of pig was raised at San Giovanni. In fact it makes sense for these darker breeds to be associated with forested but generally warm areas. Genetically they would be favoured, since their bristles would offer some protection from the elements, and their smaller more compact size would be advantageous against the overall warm climate of southern Italy. Darker-skinned breeds would not fare well in warm climates since they would absorb more solar radiation and potentially overheat,[56] unless shelter (in this case the shade of the forest) was available. Thus, warmer areas of Italy are environmentally predisposed to have smaller numbers of pigs, unless enough stall space or other appropriate shelter can be found.

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[55] Although these physical characteristics cannot be determined on the basis of zooarchaeological evidence alone.

[56] Since pigs cannot sweat, an outside temperature of over 36° C is detrimental to their health (Mount 1968: 16).

In general, pigs at Alpine sites in northern Italy are larger than their lowland counterparts. Combining Imperial and Late Antique pig measurements from two Alpine sites (Invillino and Stufels) gives a withers height average of 71.0 cm (n=30), while a similar exercise for sites in (or very near) lowland areas (e.g., Modena, Monte Barro, Altino) provides a value of 65.6 cm (n=7). Just how this relates to husbandry schemes and/or environmental factors is not readily discernible, but it is possible that more attention was paid to feeding and raising pigs at the relatively closed, and more self-sufficient settlements at Stufels and Invillino, thus encouraging larger individuals. Modena and Altino, however, may have been supplied with comparatively slightly smaller pigs that were raised in a more casual fashion in the surrounding lowland areas and specifically geared for sale at urban markets. In this manner, quantity of stock may have taken precedence over its quality.

Pig withers height comparisons amongst sites in central Italy are complicated by the fact that two breeds may have existed. Splitting the data for Late Antique sites in this area into four regions—Bay of Naples area (includes Carminiello, S. Patrizia, Girolamini), Rome and outskirts (includes Schola Praeconum, Via Gabina), Etruria and Umbria (includes Settefinestre, Lugnano) and eastern central Italy (includes Matrice)—and calculating the means both with and without the larger breeds yields the same pattern: larger pigs in the more urban areas (i.e., Naples, Rome) and smaller pigs elsewhere. Sample sizes are small in many cases (less than ten for all but Rome), so any interpretations are tentative. Nevertheless, the data suggest that urban areas received larger pigs, on average, than those consumed at rural sites. Just how many of these larger urban pigs were bred nearby, or imported from rural sites elsewhere cannot be determined, but it is possible that larger pigs from rural sites such as Settefinestre, Lugnano, and Matrice were selected from amongst the herd and moved to urban centres for consumption.

Predicting the size of pig herds in Roman Italy is difficult. The pig sty complex at the site of Settefinestre—which incidentally fits the sty descriptions given by Varro (*Rust.* 2.4.14) and Columella (7.9.10)—offers the best proof that a herd was kept. However, such structural evidence is limited in the archaeological record. Some idea about pig herd sizes can be formed on the basis of zooarchaeological data, but there is no way of verifying the statistics given in the texts. Varro (*Rust.* 2.4.22) states 100 is reasonable, but mentions that some herders keep 150, 200, 300 or more. It is possible that with some of these greater values Varro is referring to combined herds which were raised at several farms owned by the same individual. In any event, at least isolated herds of 100 pigs might still be expected. Given the preponderance of pig bones, coupled with the availability of woodland food resources at many rural and settlement sites throughout Italy, it seems logical that pig herds, rather than a collection of a few individuals, might be predicted. Nevertheless, the zooarchaeological evidence also has its limits. Faunal samples usually represent deposition over a period of time, often decades or centuries. Averaging MNI values over this period produces very meager numbers, hardly enough to indicate an actual herd. Even the impressive MNI value of 241 pigs at San Giovanni is reduced over the 90 year occupation span to just a few pigs per year. Moreover, when we consider that Varro (*Rust.* 2.4.22) also notes that pig breeders ultimately must determine the size of the herd to suit their own benefit, then predictions about herd sizes become fruitless in the absence of details on the "herder's benefit." He could keep as little as a few, or a many as 300, depending on the situation. Despite these complications, I would predict the following correlation of herd sizes and sites on the basis of available zooarchaeological and textual data. Only rural and settlement sites are included, since it is assumed urban1 sites did not raise herds of pigs, even though they may have imported pigs from such herds. I stress that this list is based on my own interpretations. Although the numbers are predicted the list gives some indication of small-scale vs. large-scale pig operations.

Few individual pigs to herds of less than 50: Gravina, Monte Irsi, San Biago, Narce, San Giovenale, San Giacomo, Pozzuolo del Friuli, Colognola, Stufels, Invillino, Torcello, Villa Clelia, Innichen

Pig herds greater than 50: San Giovanni, Le Colonne, San Potito, Settefinestre, Matrice, Via Gabina, Monte Gelato, Lugnano, Monte Barro

Indeterminate: Quintili, Palazzo Dugentesco, Lomello

The age profiles for pigs at most sites accord with the statistics given in the ancient texts. Pigs provide no valuable secondary resources such as traction, milk, or wool, and their hides are not nearly in demand compared to other animals. Their meat is most important, which is why fat pigs were encouraged as quality brood stock (Col. 7.9.1-2, Pallad. 3.151-152). Pigs could be fattened and slaughtered when they reached maximum weight, usually in their second year of life. However, considering the profundity of the sow, a number of newborn and juvenile pigs could also easily be slaughtered with no dramatic effect on the future viability of the herd.

Both dental and fusion evidence show that most pigs did not survive beyond three years, with the bulk generally killed between one and three years of age. Correlation with sex data shows that most males were slaughtered at younger ages, many in their first year, while females usually survived to older ages. The zooarchaeological data, however, do not support the texts in terms of a sow's age. A few elderly pigs are identified, but not enough to indicate that any but c. 1% lived to a maximum breeding life of seven years as Varro (*Rust.* 2.4.14) and Columella (7.9.3) claimed, let alone survived to the 15-20 year maximum life expectancy as Pliny (*NH* 8.77.206) notes. Boars could breed between one and three/four years according to the ancient sources (Varro *Rust.* 2.4.8; Col. 7.9.2; Plin. *NH* 8.77.206), but the zooarchaeological data show that much of this occurred at earlier ages within this bracket. The fact that the ancient authors do not give life expectancy figures for boars might indicate that none was allowed to reach a maximum age. The zooarchaeological data certainly support Varro's (*Rust.* 2.4.8) statement that boars should be killed before three years of age. Very few of the mandibles sexed as males had extremely worn dentition which is usually characteristic of elderly age.

Killing pigs at c. 1-3 years of age is a cost-efficient strategy. Pigs generally attain their maximum weight during their second year (Parsons 1962: 222). However, considering that ancient breeds matured a bit later than our modern breeds, this period can be extended somewhat to c. 2.5 years. The question is at what time of the year should these pigs be culled.

When weighing costs and deciding breeding and culling schedules, pig herders must always consider the availability of food resources. For sites with access to deciduous oak forests, finding feed for the pigs during the autumn months might not have been problematic since abundant quantities of acorns and mast would be obtainable. The other seasons might present a problem for the farmer, however, who would have two main options. First, he could try to find other sources of food for the entire herd. Sprouting grass might suffice to some degree in spring, and pigs might have entered the stubble for gleanings after crops had been harvested during the summer, but this would leave periods of food shortage during the winter months and late summer before the acorns fell in autumn. Therefore, at some point he would have to provide feed to his entire herd in these off seasons. However, this can be quite expensive given the voracious appetite of the pig, not to mention a herd of pigs; then there is the problem of storing these foodstuffs, or for that matter, the herds themselves. Thus, it is unlikely that entire herds of pigs subsisted on stored foodstuffs, especially through the winter months when food was generally scarce for animals and humans, and snow cover in some areas hindered or halted the search for natural alimentary resources.

A second option for coping with the problem associated with keeping pigs over the winter months was more likely implemented. In order to avoid providing food for pigs in the off seasons, it is possible that herds were culled after the autumn feeding and many individuals slaughtered at this time. Parsons (1962) further notes that in Spain the forest feeding pigs were divided into two groups, "one to be fattened for slaughter and the second, consisting of animals from six to twelve months of age, to clean up the acorns overlooked by the first" (Parsons 1962: 218). A similar example may have been used in Roman Italy. While the farmer would still have to provide some materials for the remaining pigs during the off season, there would be fewer individuals to feed. In addition, the meat, lard, and other consumables from the slaughtered individuals could be preserved and kept for the occupants to eat over the winter months, perhaps in lieu of stored crops, which could then be more freely distributed amongst the surviving livestock. Alternatively, the meat could have been sold or exchanged for feed with which to maintain the breeding herd of pigs during these harsh times.

Parsons (1962: 229) notes that young pigs, because of their protein deficient diet and immature bodily development, are not able to gain any worthwhile benefit from an acorn diet of almost pure carbohydrate.[57] For this, they must wait until their second year, when summer-born pigs would be c. 15-18 months, and winter-born pigs either c. 9-12 months (if born that year) or c. 21-24 months (if born the previous year). By the end of the autumn feeding period in the pig's second year it would have attained its maximum weight. An 18 month hog will more than double its weight during a three month autumn acorn feeding (Parsons 1962: 222). Thus, an early winter cull would see the slaughter of many adult pigs in the 18-24 month, and 24+ month dental age categories especially, but also deaths in the 12-18 month category, depending on the circumstances (e.g., demand, available resources, etc.). The fact that most pig deaths occur in this 1-3 year range as shown in Table 43 and Appendix 10 accords well with this scheme of autumn fattening and winter culling.[58]

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[57] Acorns appear to be the dominant food source for pigs according to ancient sources (Mart. 11.41; Ael. *NA* 8.9; Ulp. *Dig*. 5.14.3, 39.3.1.15; Strab. 5.1.12)

The zooarchaeological data for pigs show that no site conforms exactly to either the biannual or the annual breeding scheme as outlined by Columella (7.9.4). As noted in the analysis of seasonality above, peaks at the 3-6 month, 12-18 month, and 24+ month category in the dental statistics (Table 43 and Appendix 10) suggest an annual breeding and culling schedule with summer births and early winter culls. Fairly equal values across all of the age categories, however, might suggest a biannual scheme in breeding, with summer and winter births, but still one culling period, again usually in the early winter time. Of those sites with sufficient dental age data, only Populonia and Forum Transitorium conform rigidly to the annual scheme. It appears these urban site were supplied with pigs culled principally on an annual basis.. Otranto loosely conforms to this annual scheme, but the a seasonal pattern is not recognizable for other urban1 sites such as Schola Praeconum and Modena. There is variation among the rural and urban2 sites as well. Settefinestre, Stufels, Monte Barro, and Invillino show some accordance with the annual scheme, while the sites of Matrice, Via Gabina, San Giovanni, Monte Irsi, and Gravina generally (though never strongly) match the criteria for biannual breeding. The pattern shown is significant for two reasons. First, those rural sites which conform better to the biannual scheme are all located in southern and south-central Italy. This may relate to the fact that winter litters did not survive well under cooler conditions (Varro *Rust.* 2.4.13) in which case the more temperate winters of these southern regions compared to other areas of Italy was less of a deterrent. Winters at Stufels, Monte Barro, and Invillino, all located in northern Italy, would certainly be severe enough to inhibit anything but an annual summer delivery in pigs, especially if other animals, such as cattle, sheep/goat (and possibly winter lambs) were to be tended over the lean winter months. Any competition from piglets for food resources would need to be minimized.

The patterning of the biannual and annual pig breeding sites is also significant in that southern and south-central sites in Italy could perhaps more effectively tap into the urban demand for pork, and as such strive to produce stock twice a year. Rome is a convenient market for the pigs raised at the Via Gabina site. Rome might also have received pigs from Matrice and San Giovanni, although there are other closer urban markets such as Saepinum (for Matrice) and the cities along the Bay of Naples or the Adriatic (for San Giovanni). Moreover, the impact of taxation in kind for pigs during Late Antiquity would likely force many rural farmers in these taxed regions to increase production by intensifying or instituting a biannual breeding scheme.

The fact that the site of Settefinestre shows more of an annual breeding scheme is puzzling, especially since it had pig sties to offer protection from the elements, and is located near major urban centres, notably Rome. Perhaps resources were limited, so that the farmers at Settefinestre chose an annual scheme. Alternatively, they may have been more interested in raising quality brood stock or fat adult pigs, rather than sucklings for urban markets. It is also possible that the site was minimally affected by urban demands, and raised pigs for more immediate consumption, choosing a scheme which best suited their purposes.

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[58] Clark (1992a: 57) notes that in early 15th century central Italy the critical months for slaughtering pigs were December and January.

A herd of pigs requires proper control to be managed effectively. The ancient authors note some of the mishaps which could happen in an uncontrolled herd (e.g., Ovid [*Fast.* 1.351-352] tells how unchecked swine destroyed a field) and stress keeping good command over them to avoid damage and loss (Varro *Rust.* 2.4.20). However, this control refers principally to feeding and rounding-up of the herd and not to its breeding and culling *per se*. If herds of pigs were rather large, such as is suggested at sites like San Giovanni, Via Gabina, Monte Barro, and Matrice, then the farmer might not have been too concerned with strict seasonal schedules and stringent control of breeding. He may have culled and killed to get the numbers he needed—be it for the market, taxes, or his own meat supply—without too much concern for stock maintenance. Perhaps some herds were large enough that they would somehow naturally keep up their numbers, regardless of the distribution of age groups and sexes chosen by the farmer for slaughter. If a strict seasonal regime was not in place, then the pigs would be free to breed as they desired and perhaps throughout the year rather than specifically timed for summer (and winter) delivery as Varro (*Rust.* 2.4.7) and Columella (7.9.4) suggest. In any event, more relaxed control over a large herd of pigs, coupled with a non-uniform culling plan, would tend to leave no particular pattern in the age and sex data, and is a possible explanation for why many sites do not entirely fit the annual breeding/annual culling or biannual breeding/annual culling schemes outlined.

Small herds of pigs certainly require less effort to manage and control than larger herds. Nevertheless, in a small herd, the farmer would have to pick stock for slaughter rather carefully to avoid irreparably damaging the demography of the herd and possibly jeopardizing its reproductive capability or survival. The zooarchaeological data are insufficient to test this possibility, since the majority of sites suggested to have smaller herds of pigs also have limited age data.

Pig sex ratios as determined from the zooarchaeological data never conform perfectly to the expected figures of one boar to every ten sows as stated by Varro (*Rust.* 2.4.22). Aging evidence does show a tendency to kill males young, and let more females survive to older ages, but in many cases both sexes survived to at least one year of age and often into their second. Males generally dominate, accounting for c. 60-80% of the sexed pig canines at sites with larger sample sizes, but not to the extent expected by the ancient authors' standards. While the 1:10 boar:sow ratio might be sought, it would never show in a closed system. Assuming an equal chance for male or female births, and that all stock was culled and slaughtered at a site with no import or export of pig carcasses, then bone evidence should show a fairly equal proportion of males and females. Even if this was displayed as predominantly young males and older females, the ultimate ratio would still be 1:1. Taking into account the greater chance of recovering and identifying adult canine teeth, then we might expect to see females predominate over males. Why then do most sites show a reverse pattern?

A number of explanations may be put forward to explain the male pig preponderance at many of these sites. Perhaps the simplest explanation is sample bias. It is possible that female canines may have been missed during recovery because they are smaller teeth. Additionally, perhaps more of them existed as unrecognizable fragmentary pieces. These explanations, however, seem unlikely, especially at sites where screens were employed in bone recovery and where area excavations were conducted.

Better explanations for the male bias in the pig samples take into account the specific cultural conditions at a site. We might expect males to predominate at urban sites, since they were not especially needed for breeding, and could be readily consumed. The pig sex data support this to a large degree, with major urban sites such as Otranto, Pompeii-Ganimede, Carminiello, Populonia, Girolamini, and San Omobono, as well as some settlement sites such as Roccagloriosa, Pozzuolo del Friuli, and Invillino posting averages of c. 60-80% males. However, some obvious exceptions exist (e.g., Spina, S. Patrizia), for which an explanation is needed, but unknown. Columella (7.9.4) outlines a breeding scheme for farms which are close to markets (presumably urban markets) wherein pigs breed twice a year with many sucklings sent for urban consumption. Had most of these been males, as expected, then a male bias would appear at urban sites. This hold true. Aging data, however, show incredibly mixed results in terms of the number of sucklings consumed at urban sites. If we assume sucklings to be up to six months of age (a generous age range), then of the nine urban1 and urban2 sites listed above with male pig biases, only Populonia, San Omobono, Girolamini, and Pozzuolo del Friuli register enough sucklings (i.e., more than 40%) to suggest that they were supplied by some neighbouring farm practicing Columella's (7.9.4) sucking-pig production scheme. That most of these sites are located in central Italy highlights the importance the pig trade in supplying urban centres of this region with relatively expensive meats.

Castration cannot be proven from the zooarchaeological data alone. The effects of castration on the pig skeleton are not fully understood, and the same problems that plague the recognition of castration in sheep/goat (i.e., variation in fusion rates, complications of other factors such as breed, nutrition, level of activity, etc.) apply here. Moreover, it is unknown how the canine tooth is affected, but I would suspect that castration would do little to alter the form enough where a male canine might assume a more noticeably feminine shape. A castrated boar's canine would probably still be classified as male. Although boars average greater weight gains than barrows (Turton 1969: 34) their meat contains significantly more moisture and protein and significantly less fat (Turton 1969: 41). In addition, it has a much stronger, somewhat tainted taste (Turton 1969: 1, 41). Castration appears to have been commonly practiced in Roman Italy according to the ancient sources (Col. 7.9.4; Varro *Rust.* 2.4.10). Since fat pigs were preferred for consumption in Roman Italy, it follows that most males were castrated, since this causes them to become fat (Turton 1969: 40-41; cf. Col. 7.9.4). Moreover, since castration would reduce the territorial and ferocious nature of true boars, it would be advantageous especially in smaller herds kept around the farm and subject to greater human contact and control. Castration seems less likely amongst larger herds kept in a more casual fashion, but there are no data to confirm this.

Finally, the generally healthy state of pigs from Roman Italy as recorded by their bones is consistent with textual references to keep sties clean and disease free (Col. 7.9.14), and be wary of epidemics (Juv. 2.78-79; Plaut. *Trin.* 2.4.539-540). As in the case of sheep/goat skeletal pathologies, relatively insignificant, non-contagious, and non life-threatening dental pathologies such as calculus and periodontal disease are more common than any post-cranial skeletal abnormality in pigs. The texts make no mention of dental pathologies in pigs, choosing to concentrate on symptoms and remedies of the seemingly more prevalent non-skeletal pathologies conditions.

Chapter 6

DISCUSSION:

TESTING THE MODELED CRITERIA FOR PRODUCTION

Although there are various modeled criteria which distinguish a production site (as outlined in Chapter 4 above), not all of these are recognizable in the zooarchaeological record. I consider each separately below as it relates to animal production in Roman Italy.

(1) Evidence that a surplus of animals was raised

This is perhaps the most difficult criterion to measure using solely the animal bone remains from archaeological sites. There is no fixed number of bones beyond which constitutes a "surplus" for this is relative to the population at the site and the duration of occupation. Even the most impressive NISP and MNI sample sizes are reduced considerably when averaged over the span of occupation as well as the estimate of the meat-eating population at any given site. For example, as stated above, the site of San Giovanni had an MNI of 241 pigs in its middens during the final phase of occupation. This is the greatest MNI for any domestic mammal recorded of all the Roman period sites in Italy to date. However, even when assuming that every part of these 241 pigs was consumed at the site, this figure becomes an unimpressive 0.11 pig/person/year when averaged over the 90 year time span of this final occupation phase and using a population estimate of c. 25 individuals for the site.[59] This converts to about 5 kg of pork/person/year at San Giovanni, which is hardly a "surplus." Even if meat was not consumed regularly, any elite individual likely ate more than 5 kg of pork/year.

If even the data from San Giovanni cannot document a "surplus" using a mathematical calculation, then it is doubtful that any other site will be of much help in this respect, considering most tally much smaller MNI values over generally longer time periods. Furthermore, population estimates have not been tabulated for nearly all of these sites, leaving it impossible to calculate the amount of meat available to each person. Even without these parameters, however, I expect that most sites would register far less than San Giovanni's somewhat paltry figure of 5 kg of pork/person/year. The only other site with a larger sample of animal bones than San Giovanni is Invillino. MNI values were not calculated for Invillino, but its total mammalian NISP figure is about double that from San Giovanni. If we assume a similar doubling for MNI, then this site would still record a value of less than 5 kg of meat/person/year, since it is much larger than San Giovanni and presumably had a larger population as well.

Although the site of Kaulonia claims fairly impressive MNI figures compared to other sites, and could potentially show a "surplus" if these values were subjected to calculations like those above, I do not believe these MNI values were calculated in the same or even similar manner as those in other reports, since they are incredibly high compared to corresponding NISP values at this site (Kaulonia NISP=751, MNI=329; see Tables 16 and 17 for comparisons). For this reason I doubt they can be used reliably in any calculation such as "surplus," but they may be of some value for comparing relative proportions of mammalian taxa at the site.

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[59] Freed (1982) estimated the population during Period 3B at San Giovanni at between 20-30 individuals on the basis of pottery studies. I have used the mean value of 25 in my calculation above.

It would seem that any mathematical calculation designed to define the amount of meat per person per year at any given site is never destined to produce values substantial enough to indicate a "surplus." Two major factors inhibit us from achieving absolute figures. First, the recovered bones are generally just a sample of all the bones deposited. Even in an area excavation there are bound to be spots outside of the site where bone refuse was discarded. Moreover, what is recovered is never what was originally interred considering the destructive and altering capabilities of taphonomic factors. Since we will always be dealing with samples or subsets of larger data sets it is impossible to derive absolute figures which require the complete set of data.

A second inhibiting factor to defining "surplus" on the basis of zooarchaeological data is that MNI figures only record the absolute minimum number of individual animals as represented by the recovered bone remains. This value would certainly increase had larger samples of bones been unearthed, but it would also increase if a "mean" or "maximum" number of individuals could be tabulated. Thus, the numeric value is very much restrained by the sample size and, at this stage, limited to a minimum value.

Distinguishing a "surplus"—a value which requires the maximum number of bones and quantifiers which record maximum values—on the basis of smaller samples of bones and minimum numbers of individuals will always be counterproductive as long as we view the resulting meat/person/year figures as absolutes. A better route might be to compare such figures from a number of sites to see if patterns develop which might be attributed to rural or urban settings. Rural sites may generally record higher values which might suggest that they fulfilled some productive aspect and were more disposed to generate a "surplus" of animal goods as opposed to urban sites. However, until population estimates become available for each site,[60] it is impossible to judge if the bone remains at any site represent an amount in excess to the normal dietary requirements of the inhabitants.

(2) An excess of butchery elements, or a lack of butchery elements but other archaeological evidence for animal husbandry

Both of these points relate to the form in which animals were moved from production site to consumption site. If animals were slaughtered at production sites and then transported as either fresh carcasses or preserved sections of meat to consumption sites then it follows that the slaughter waste and initial butchery refuse would be discarded at the production site, provided these materials too were not exported. Considering transport costs in antiquity, however, it seems unlikely that slaughtered carcasses including the head and extremity waste products were carted into towns when it would have been much more economical to have the animal walk there for slaughter. Therefore, if large groups of animals were raised at a production site, such as a rural farmstead, but subsequently herded on the hoof to a consumption site, then we might expect to find archaeological evidence for raising stock at the production site, such as stalls, feeding troughs, and so forth, but few bone remains there. Any bones recovered at the production site in this scenario would be the remains from meals consumed at the site, since the rest of the stock would have been moved to provide meat and other consumables for other sites, especially urban ones.

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[60] This is inconceivable at present, but not necessarily improbable in the future.

The two scenarios described above represent both extremes in the zooarchaeological patterning at a production site - from a near absence of bone remains (suggestive of herding on the hoof) to a preponderance of butchered elements, especially the waste products of the head and feet. No site fits ideally into one of these, which makes it difficult to label them as production sites. Some of the more probable candidates include San Giovanni, Settefinestre, San Giacomo, Stufels-Hotel, and Colognola. Each of these sites contained an excess of slaughter and initial butchery waste products such as the head and extremity bones. This pattern was displayed for all three of the main domestic taxa—cattle, sheep/goat, and pig—at the sites of San Giovanni and Stufels-Hotel, for pigs and sheep/goat at San Giacomo and Colognola, but primarily just for pigs at Settefinestre. The impression is that the better primary and secondary cuts of meat including the bones within were exported from these sites, or disposed of elsewhere at the site. The latter option seems unlikely at San Giovanni and Settefinestre where the entire villa complex, including some surrounding territory was excavated. Thus, these two sites in particular best fit the criterion of "excess of butchery elements" which characterizes a production site. Differential disposal of a portion of primary and secondary cuts at the other sites listed above cannot be disproved, but the mix of refuse recovered from these sites, which included both whole and partial animals, suggests no great selectivity to trash disposal. It seems that at least some primary and secondary cuts were exported, thereby leaving an excess of butchery waste at San Giacomo, Stufels-Hotel, and Colognola. Each site was probably involved in production, but the data do not allow us to quantify this to any degree.

At the opposite end of this extreme, a production site may have very few animal bones if most animals were moved on the hoof to markets and elsewhere for slaughter and processing. Animal stalls have been recognized in the archaeological remains from several Roman period sites in Italy,[61] but out of all the sites where zooarchaeological remains were also recovered, only Settefinestre has evidence for enough stalls to house more than just a few animals. Excavations here revealed a large piggery with over 40 sties. Each sty conforms roughly to Columella's (7.9.10) and Varro's (*Rust.* 2.4.14) specifications. Rooms for animals have been noted at other sites such as Gravina, San Giovanni, and Monte Irsi, but most seem designed to house only a small number of cattle and/or equids. I suspect these were where plough oxen and other working farm beasts were contained, since they had to be kept and maintained on the farm outside of the working season. The animal stalls at San Giovanni opened to the south as instructed by several Roman agronomists (Varro *Rust.* 1.13.1; Col. 6.22.1; Pallad. 1.73).

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[61] Rossiter (1978) provides several examples, but corresponding zooarchaeological data are only available for the site of Monte Irsi in his list. Morris (1979) discusses stock buildings (i.e., sheds, byres, enclosures, pens, stables, sties, etc.) in Roman Britain. A problem is that the function of many rooms cannot always be determined on the basis of available archaeological and architectural evidence. Often the designation of "stable," "pen, " etc. is based chiefly on the position and dimensions of the room or structure in relation to other rooms, and not on zooarchaeological, botanical, entomological or other biological or chemical (e.g., phosphate) evidence which might help indicate the room's inhabitants.

In light of the archaeological evidence for pig sties and cattle/equid stalls, it is no surprise that the ancient authors provide more details about their construction than for stalls for other animals. Sheep stalls are mentioned but generally in the context of housing either pregnant ewes or special breeds such as the Tarentine. In neither case are construction details given, and the impression is that any stall could be used provided it gave the necessary protection. Most sheep were probably never housed in any type of expensive permanent structure. Large flocks were encouraged making it very difficult to find adequate stall-space for all. Moreover, transhumant flocks would only be using the shelter for a short period of time in any season. Temporary sheep pens and fenced enclosures, traditionally made of wooden post and rope netting, have been noted in ethnoarchaeological research in Italy (Barker 1990: 112).

While the presence of animal stalls likely indicates that animals were housed at an archaeological site, their absence does not necessarily imply few or no animals were kept. Stone structures are obviously more apt to survive in the archaeological record, but in most cases stone was an expensive building material, more likely to have been used in building animals stalls at wealthier estates. Wooden structures, shelters of wattle, timber boughs, and thatch must have also been used (Morris 1979: 42), but would leave little archaeological trace. Regardless of the material used for their construction, however, stalls are still an added expense and probably only worth the effort and cost if relatively valuable animals such as plough oxen or traction equids are to reside there. Although any farmer wishes for healthy stock, it was particularly important for oxen and equids to remain in good form[62] considering usually only up to a few were kept at any given farm and each was quite expensive to replace. Stalling larger herds of animals would require a great deal of space, and might not be worth the extra cost considering the relative ease in replacing stock which may get ill from lack of any permanent, indoor shelter. Presumably some type of refuge, even if just a rough canopy or lean-to, could be erected as required to provide some protection from the elements.

(3) A non-realistic herd structure

Distinguishing a non-realistic herd structure in the zooarchaeological record hinges on identifying sex and age patterns from the animal bones. Production sites tend to have more breeding females but few mature males. Females are retained at the site for propagation while most males are slaughtered young (either on site or transported elsewhere). Generally, only a select few males are kept for breeding purposes.

As noted earlier, not all reports of Roman period sites in Italy contained information about animal age and sex patterns. Two rural sites—San Giovanni and Monte Barro—as well as three urban2 sites—Pozzuolo del Friuli, Innichen, and Invillino—all showed evidence of more older cows than oxen and bulls, which might be used in labeling them "production sites," at least in terms of bovine resources. The preponderance of cows at these sites suggests each had some role in milk, but more likely cheese, production. Furthermore, it is not unexpected that all of these sites, save San Giovanni, are located in northern Italy, a region known for dairying in antiquity.

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[62] In support, the ancient agricultural and veterinary writers devote far more attention to the care of cattle and equids than any other animal. Bodson (1983, 1984, 1986) and Walker (1973) provide further information and ancient references about the welfare and treatment of livestock and work animals during Roman times. Fischer (1988) surveys the Greek and Latin sources on veterinary medicine.

Although cows generally predominate over oxen and bulls at most rural and urban2 sites, the pattern is reversed in a couple of cases. Oxen and/or bulls outnumber cows at Stufels and Torcello. They are also more plentiful at Aquileia and Volano. Oxen were principally raised as working animals and trained to pull the plough and various carts or wagons. Their predominance, indeed even their presence at various rural and urban2 sites (assuming local consumption and no import of beef to these sites) may be a sign of agricultural production since as expensive animals there would be little reason to keep oxen on site unless they were being put to work somehow. Cows would be better raised if beef exploitation was the primary goal of the farmer. Cows would be more docile than bulls and oxen, and could provide milk for cheese throughout their life, in addition to meat and hide for leather upon slaughter.

The situation for sheep and goats is somewhat different than that for cattle. Ewes should predominate over rams if stock breeding and meat production was important, but a greater balance between the sexes might be expected if rams were castrated and both sexes raised principally for their wool (or hair in the case of goats). The former would appear as a "non-realistic" herd profile in the animal bone age and sex data while the latter would not. The fact that older female sheep/goat outnumber males at the sites of Gravina, Cozzo Presepe, Monte Barro, and Colognola, suggests each of these had some role in caprine production. The lack of males denotes some degree of export, and considering the demand for lamb and kid in antiquity, coupled with the higher price they carried relative to mutton,[63] I suspect some of these young males were moved to urban markets. However, while the sale of meat may have figured in the production schemes of these sites, herders and flock owners likely also exploited the older breeding stock for wool. In many cases this was probably the thrust of the caprine economy. Gravina and Cozzo Presepe both lie in pastoral areas of southern Italy traditionally known for sheep-raising and wool production.

A greater balance between the numbers of male and female sheep/goat occurs at the sites of San Giovanni, Matrice, Invillino, and Stufels. On the basis of other criteria, such as the presence of draught oxen (see above) and imbalance in pig sex ratios (see below), it seems that each of these sites fulfilled some productive purpose even if the caprine age and sex data do not indicate a "non-realistic" herd structure. I suspect wool exploitation was more important to these sites than the production of lambs and kids for the market. Wool production would not necessarily leave a distinct trace in the zooarchaeological sex ratios, especially since it often results in a large collection of castrates, which, as noted earlier, are difficult to distinguish osteologically. The net result, assuming castrates are recognized as males on the basis of their bones, would be a balance in the number of males and females. Wool exploitation, however, would see a greater proportion of the flock raised to older ages, a condition generally noted by the higher frequency of adult sheep and goats at sites such as San Giovanni, Matrice, Invillino and Stufels. It is impossible to determine if the flocks at these four sites were larger than those from Gravina, Cozzo Presepe, Monte Barro, and Colognola, where older female sheep predominate over rams (see above). On the basis of NISP data, sheep/goat bones are most numerous (relative to those of other animals) at Invillino, Stufels, Gravina, and Cozzo Presepe, which suggests that these sites maintained the largest flocks of those listed above.

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[63] The Edict of Diocletian prices lamb (*Ed. Diocl.* 4.47), and kid (*Ed. Diocl.* 4.48) at 12 *denarii*/pound, but mutton (*Ed. Diocl.* 4.3) at only 8 *denarii*/pound. Young milk lamb is still highly prized in Italy, fetching more than double the price per kilogram of mutton (Barker and Grant 1991: 73).

There is far less of an imbalance between the sexes for pigs, and in most cases males predominate slightly over females, a pattern contrary to what is expected in the modeled criteria. Settefinestre is the only site (with available data) where older females are more numerous than males, but the ratio is relatively meager: approximately two adult males for every three adult females. The preponderance of males might be related to the larger size and increased survivorship and recovery of the sexually dimorphic male canine tooth over its smaller female equivalent, but this should not be a major problem for sites like San Giovanni where screens were employed extensively in bone recovery, and where other criteria point towards this being a production site, especially for pigs. San Giovanni registers approximately eleven mature males for every nine females, hardly what would be expected had humans been interfering extensively in breeding to limit the number of adult boars.

Considering the number of sites with productive tendencies which do not fit the criteria of a "non-realistic" herd structure, I suspect that in many cases human intervention into the natural distribution of ages and the normal balance of sexes within an animal taxon was limited. For example, if pigs were herded in a rather casual fashion as is suggested for sites like San Giovanni (MacKinnon, in press), and possibly others such as Gravina, Via Gabina, and San Giacomo, all of which record more boar than sow remains, then it is possible that more males survived to older ages. None of these sites contained a piggery, and it seems that pigs were fed in the neighbouring forests or fields around the site in each case. In contrast, Settefinestre is the only site where older females outnumber mature males, and also the only site with evidence of keeping pigs in a closed environment, in this case a pig sty complex. The control afforded by keeping these pigs in this manner likely allowed the breeder to select stock more readily, and reduce the number of relatively useless older males in favour of productive breeding females.

(4) Evidence of young animals in the dental data but not in the fusion data

This criterion of a "production site" connects in part to no. 2 above, in that it too relates to the movement of goods. It implies that the better quality meat cuts from slaughtered, expendable, young and generally male animals were transported to consumption sites, leaving behind the waste products such as the head and feet at the production site. Consequently, the dental data at the production site would show the presence of younger animals whereas the fusion data would record an absence of them, since the majority of skeletal elements which mature through fusion of epiphyses would be exported.

Recognizing such a pattern depends on tabulating ages from both dental and fusion data. These were reported for less than half of the Roman period sites in Italy used in this thesis, so there are a number of sites which could not be tested. Nonetheless, the data for cattle show more younger animals on the basis of dental evidence than on fusion evidence at the sites of Monte Irsi, Monte Barro, and San Giovanni. This pattern is consistent for all of these sites at two age levels: less than one year and less than two years. Stufels and Innichen may also have fulfilled some role as cattle production sites since there are many young calves represented in the dental data; however, in the absence of the comparative fusion data from these sites, this hypothesis remains untested.

More sites yielded aging data for sheep/goat. Gravina-pit, Cozzo Presepe, Matrice-period 1, and Monte Barro had more younger lambs/kids (i.e., less than one year) on the basis of dental data than on fusion data, thus fulfilling the criteria of a production site. Settefinestre, Via Gabina-site 10, and San Giovanni join this group when the fusion category is moved to the next leve (i.e., the 14-36 months group) and the comparative dental data examined from those individuals less than three years. These sites had more sheep and goats younger than three years of age as indicated by dental data than fusion data.

While most of the sites identified as production sites on the basis of comparative sheep/goat dental and fusion data are either rural or urban2 sites, the pattern is not always consistent. Matrice-period 2&3 and Gravina record more younger lambs/kids in the fusion data than the dental data (at less than one year of age), which is the opposite of what is expected for a production site. At the same time several urban1 sites—Modena, Carminiello, and Populonia—fulfill these criteria of a production site, when we might have thought they would register otherwise. Even within one site the situation may change depending on which age level is used. For example, while the sites of Matrice-period 1 and Populonia show more younger lambs and goats less than one year on the basis of dental data than fusion data, they lose their "production site" status when the aging data from individuals less than three years are compared.

The aging data for pigs are equally inconsistent. Gravina, San Giovanni-period 2, Matrice-period 1, and Monte Barro all show more younger pigs in the dental data than in the fusion data at either one of two levels: less than one year or less than two years. However, none of these sites is concordant at both of these age levels. San Giovanni-period 2 just fulfills this production site criterion at the "less than two years" category while all the other sites listed above do so at the "less than one year" level.

Otranto, Populonia, and Carminiello-period 3 are the only urban1 sites which had more younger pigs in the dental data than in the fusion data, but several rural and urban2 sites show either a balance between the two sets of data (i.e., indicative of neither production nor consumption as represented in the modeled criteria) or else record more young pigs on the basis of fusion data than with dental data (i.e., suggestive of consumption and not production). Even sites which may otherwise fulfill some of the modeled criteria of a production site (i.e., criteria 1-3 listed above) fail to meet this age comparison criterion.

Despite the huge volume of pigs bones recovered at San Giovanni-period 3, this site shows more younger pigs in the fusion data than the dental data, which goes against the anticipated pattern for a "production site." This conundrum requires explanation.

There are certainly many variables which influence economic decisions on a Roman farm. Production of piglets is feasible only when the producer site is located near a market or some other type of consumer site which can import these animals. While larger, older animals can walk to market, and sometimes over great distances if needed, newborn and very young animals simply do not have the stamina for such journeys. Thus, it is possible for sites to still produce principally mature animals for some consumer(s), but at the same time retain younger individuals for their own consumption. The result would reveal itself in the zooarchaeological record as evidence for younger animals. If cuts from these younger animals were preserved and exported then, depending on which parts were moved, an imbalance between dental data and fusion data might result. While we tend to view the export of presumably better-quality post-cranial elements from a production site as predominating over the export of cranial elements, it is possible for a producer to reverse this pattern. A producer may chose to keep the better cuts for his own consumption, and export or sell locally the heads to others. The result would show as a predominance of younger animals in the fusion data but not in the dental data, indicative of consumption patterns of the producer. This could, however, coincide with other faunal patterns characteristic of stock production of mature animals for outside markets, also shown from the same producer site. The fact that a producer site will also contain evidence for consumption is a problem. Often components of both modeled schemes will be revealed in their faunal data.

(5) Archaeological evidence for the existence of meat preservation, either salting, drying, or smoking, if this occurred prior to export

This criterion of a production site is difficult to recognize. The animal bones themselves provide no direct clues to meat preservation, while structural and artifactual evidence is conjectural. Much of the equipment used to preserve meat such as the drying racks, tables, etc., was probably made of wood which does not normally survive in the archaeological record. No vessels, ceramic or otherwise, expressly associated with meat storage or preservation have been identified from excavations. Moreover, there appear to have been no specific modifications made to a room which might characterize it as a preservation room. It could have served a variety of purposes and as such need not be structurally altered for any one of these. A large oven was built in the doorway between two non-residential rooms at the site of San Giovanni-period 3. It was constructed sometime during the last phase of occupation at the site and may be associated with the smoking of meat stripped from the contemporary bones which were discarded in the same area (MacKinnon, in press). Other than this, however, there is no definitive archaeological or structural evidence for meat preservation in Roman Italy.

(6) Literary or textual references alluding to the productive nature of a site or area

This final indicator of a production site does not rely on the zooarchaeological data, but rather the literary and textual realm. As such, it is not readily testable using material remains and therefore is more ambiguous in nature. There are two levels. First, assumptions about production or consumption status are made on the basis of site-type. The texts characterize rural farmsteads as generally producers and urban centres as principally consumers. In a similar manner we might presuppose rural archaeological sites as producers and any urban1 site as a consumer. Overall the zooarchaeological data from most rural sites fulfill much of the modeled expectations of producer sites, while a similar correspondence generally exists between urban1 sites and the modeled criteria for consumer sites. Urban2 sites, however, often lie amid these two extremes which makes it difficult to identify them as either producer or consumer.

On the second level, the ancient sources note several regions of Italy which were known for animal production. In general, cattle were principally herded in sections of northern Italy. Sheep/goat husbandry predominated in the south but was also practiced in some northern areas. Pig raising was important in the forested districts of northern, central, and southern Italy. Farms near cities were encouraged to produce many piglets and lambs to take advantage of the strong urban demand for tastier younger animals. All things being equal then, we might expect the zooarchaeological data to correspond to these textual references and on a broad level they do. Southern Italy, on average, has a higher proportion of sheep/goat bones than other regions of Italy. Northern Italy records the highest relative frequency of cattle remains, while pigs are particularly abundant at sites near woodland resources, or in sections of Italy mentioned as pig-producing zones such as Lucania, Samnium, and the Po valley.

Cases exist where the designation of a site type or knowledge of a geographic area correlates with the recognition of production or consumption activities in the zooarchaeological data. For example, San Giovanni is a rural site located in an area of Italy —Lucania—which is referenced as an important pig-raising zone during Late Antiquity. The zooarchaeological data generally support it as a production site for pigs especially, which concurs with expectations from the site-type label as "rural" and the ancient references to Lucania as a pork producing region. In a similar fashion, the Schola Praeconum site is located in urban Rome, a city known for its relatively immense aggregate demand of many products including food resources. On the basis of the urban1 and geographic label (i.e., Rome) we might surmise that the Schola Praeconum was a consumer site, an assumption which is supported by its zooarchaeological data patterns, almost all of which fulfill the modeled criteria of a consumer site. While a couple of sites may show great correlation in this manner, however, there are many sites where the zooarchaeological data do not correspond to the textual references which indicate production. Not all rural sites appear as producers on the basis of their zooarchaeological data. Conversely, not all urban1 sites show the expected characteristics of consumer sites. Some sites emerge as producers in some aspects but consumers in others. The lack of good correspondence between the textual and zooarchaeological data reinforces the need to examine both to achieve a more accurate picture of the animal economy of Roman Italy.

Chapter 7

RESULTS: CONSUMPTION

Part 1: ANIMAL BUTCHERY, MEAT PRESERVATION, and COOKING

Animals have to be slaughtered and butchered before their meat can be consumed. That meat not destined to be eaten fresh must be preserved somehow. Today, these activities are normally routinized and compartmentalized in modern-day slaughter-houses and meat-packaging plants. Contemporary manuals and guides provide step-by-step details of the mechanics involved. While the basic procedural foundation has probably not changed much since antiquity—kill the animal, dress the carcass, reduce it into manageable parts, prepare those parts for consumption and/or preservation—much variation can occur at each stage. Both zooarchaeological and textual evidence help reconstruct these activities for Roman Italy.

Zooarchaeological Evidence

(i) Butchery

Summarizing the data on animal butchery from Roman period sites in Italy is difficult. Only about one-third of the sites provided such evidence, and the fact that many yielded no details should not be interpreted as absence of butchery. Even in those reports which considered this topic, however, there are complications because there is no standard method of cataloguing and reporting this information. Some reports detail specifics about the tools used to dismember and butcher animal carcasses; others do not distinguish tool types, simply referring to any signs as "butchery marks" or "cuts." Some reports indicate the precise location of each mark through descriptive text or diagrams; others provide no such details. Some reports draw interpretations about the skill-level of the butcher or the processes of slaughter, butchery, and preparation for consumption, on the basis of the pattern of butchery marks. Whereas the study of age, sex, or morphometrics is amenable to statistical analysis, that for butchery is hindered by excessive variation.

Despite the complications associated with the analysis of butchery, the data can still provide clues about trends, be these over time, amongst site-types, or across geographic regions. Tables 49 through 51 summarize the information on butchery obtained from the faunal reports for Roman period sites in Italy. Only data on the three primary mammalian domestic taxa are presented. Table 49 shows the pattern for cattle, Table 50 that for sheep/goats, and Table 51 that for pigs. Butchery information for other animals was rarely recorded. The sites in Tables 49 - 51 are arranged according to geographic region, time period, and site type.

General Butchery

Cattle

It is difficult to recognize patterns in the data from Table 49 since many of the sites listed yielded no details of what type of tool caused each butchery mark. From the information available, however, it appears that cleavers were the most common implement, followed by knives. Saws were infrequently used in cattle butchery and do not appear until Imperial times, becoming slightly more widespread in Late Antiquity, but never replacing other tools. They were primarily reserved for the disarticulation of legs from the body (and in horn removal, see section below) and not in the separation or bisection of vertebrae or ribs. The positioning of chop marks—generally at the articular ends of bone—indicates that cleavers were principally used to separate the carcass into joints of meat. Knives may have assisted in this process, but also fulfilled an important function in both hide removal and filleting on meat from the bones, judging by their placement and frequency. Knife cuts along the bones indicate meat removal, while those in the region of the lower foot (i.e., metapodials, carpals, tarsals, and phalanges), an area of poor meat, tend to be associated with the hide removal.

The data reveal little about slaughtering processes. The relative absence of cranial bones amongst the sites might suggest that cattle were killed by a blow to the head, perhaps strong enough to shatter skull elements rendering them more susceptible to taphonomic disintegration. Evidence for slitting the throat is inconclusive. A set of cow hyoid bones recovered from Metaponto shows slash marks which might be attributed to such an activity. The data from Table 49 show that butchery marks are indicated on neck vertebrae from several sites; however, in the absence of detailed information about their exact location it is difficult to determine if these were related to the cause of death (i.e., decapitation or slitting of the throat) or if they are associated with the subsequent butchery or filleting of the neck area.

The longer cattle leg bones show more butchery signs than any other element of the skeleton. The neck of the scapula is often chopped to separate the front leg from the body. There are few marks on other areas of this bone, thereby lending support to the hypothesis that meat removal from the scapula was generally so delicate or minimal as to leave no traces on the bone. The humerus is detached from the rest of the leg by chopping at its distal end or by chopping at the proximal end of the radius and ulna with which it articulates. This area has left many butchery traces - the distal humerus/proximal radius/ulna registering more examples of chop lines than any other cattle long bone. The rest of the front leg is disarticulated by chopping in the distal radius/proximal metacarpal area, with some further separation at the distal metacarpal or within the carpals and phalanges.

The back legs of cattle were removed in a similar manner to the front ones. They were normally detached by chopping either at the pelvis or at the proximal end of the femur. Chops then at the distal femur or proximal tibia, as well as along the metatarsal and in the tarsals and phalanges further served to separate parts of the lower back legs.

Binford (1978: 23) and Thomas (1989: 81) note that the chances of finding complete long bones increase towards the extremities where the meat value decreases. The cattle data from Roman period sites in Italy agree with this pattern. As recorded in Table 26, relatively more whole metapodials were recovered than any other long bone. This pattern is consistent regardless of site type, geographic area, or temporal period. However, the rural and urban2 sites listed in Table 49 tend to exhibit a greater variety than their urban counterparts, in terms of location and number of butchered elements, as well as in the type of tools causing such marks. Recall from Table 26 the number of complete long bones associated with each temporal period. If these sites are re-arranged according to site type, then rural sites register the greatest frequency of complete humeri, radii, and tibiae of all site types. Urban1 sites contained no complete long bones aside from metapodials, while the average for urban2 sites registers between the rural and urban1 extremes. Rural and urban1 sites also show more evidence for chopping long-bones along the shaft, a procedure generally associated with the removal of marrow. These data support the hypothesis that cattle were more commonly killed and butchered outside of urban centres, with select parts then brought into the cities. The lack of complete long bones, aside from the metapodials, at urban1 sites might indicate that butchery was more destructive on cattle bones in towns rather than in rural settings.

Sheep and Goats

Table 50 summarizes the information on sheep and goat butchery obtained from the faunal reports for Roman period sites in Italy. The sites are arranged according to geographic region, time period, and site type. The pattern displayed for sheep/goat butchery in Table 50 is similar to that for cattle (Table 49). Again, most of the marks were caused by chopping the bones, especially their articular ends, with cleavers. Saws were almost never used to butcher the sheep/goat carcass; only one example is reported—a distal end of a humerus from the site of San Giacomo. Knife lines appear with greater frequency, on both more parts of the sheep/goat skeleton and at more sites, compared with those on cattle.

The data provide only speculative evidence about the slaughter of sheep and goats. Neck vertebrae at some sites exhibit chop and cut marks, but again details about them are sketchy, so the marks cannot be attributed positively to either slaughter or subsequent butchery.

Of all the parts of the sheep/goat skeleton, the long bones contain the majority of butchery marks. The front limb was detached by chopping through or near the neck of the scapula, or alternatively at the proximal end of the humerus. The former method seems to be favoured, considering more scapulae than humeri show cut marks, even when we compensate for taphonomic biases between the two elements. However, these two methods of disarticulation co-occur at several sites (e.g., San Giovanni, San Giacomo, Naples-Girolamini), which suggests some degree of flexibility in butchery methodology, or separation of a smaller cut of meat composed of just this section (i.e., neck of scapula through to proximal end of humerus). The remainder of the front leg was further disarticulated at the radial/humeral joint by chopping either (perhaps both?) the distal end of the humerus, or the proximal end of the radius and ulna. There appears to be great variety in the placement and angle of this cut. In some cases it occurs down the shaft of the bone, which might also indicate breakage for marrow. An abundance of butchery marks all over the metacarpals denotes much activity in this region. Chop marks attest to some disarticulation such as separating the metacarpal, either with or without the toes, from the rest of the front leg. A similar pattern is observed for the metatarsals and the back leg. The preponderance of butchery marks on the metapodials, coupled with their relative scarcity amongst the phalanges suggests that the lower feet of sheep/goats were often discarded whole. This is confirmed by the fact that complete metapodial bones clearly outnumber other complete long bones regardless of site type, geographic area, or temporal period as recorded in the distribution sheep/goat bones with GL measures (see Table 38). Moreover, the fact that the sheep/goat metapodials frequently exhibit knife lines in a variety of directions and at a range of depths suggests skinning as a probable cause. Little meat surrounds the sheep/goat metapodial, and what is there is of poor quality compared to other parts of the skeleton. Some marks could result from defleshing, and the fact that there is less meat in this area to cushion any blow might increase the chances of a knife contacting the bone; however, it seems unlikely much time would be devoted to defleshing the metapodials since the bones of the feet, which also have little and poor-quality meat, show no comparable signs of butchery.

The back legs of caprines were disarticulated in much the same manner as those from cattle. A chop at the acetabulum of the pelvis or at the proximal end of the femur served to remove the back leg, which was further divided into sections at the femur/tibia junction and at the metatarsal/tibia joint. Chop marks along the shaft of the femur and tibia, noted at some sites, likely resulted from breakage for marrow extraction.

Finally, the data from Table 50 show that sheep/goat butchery patterns are similar to those of cattle in that rural and urban2 sites generally register the greatest variety of tool types, loci of cuts and chops, and range of skeletal elements affected.

Pig

Table 51 summarizes the information on pig butchery obtained from the faunal reports for Roman period sites in Italy. The sites are arranged according to geographic region, time period, and site type. The data in Table 51 are not exceptionally different from those for sheep/goats or cattle (see Tables 49 and 50). There are relatively more butchery marks on skeletal elements associated with the head of the pig compared to similar elements from other animals. More activity was certainly concentrated on removing muscle tissue, tongue, brain, and other edible resources from the head of the pig, as opposed to the heads of other animals. Post-cranially, however, pigs were disarticulated in much the same manner as cattle and sheep/goats. Cleavers were principally used to chop through joints, while knives assisted in filleting meat from the bone. More saws were employed in pig butchery than in caprine butchery. Several sites record sawn pig long bones and cranial pieces.

There is insufficient evidence to determine how pigs were slaughtered. Marks are recorded on neck vertebrae at some sites, but it is unknown if these relate to the cause of death or are the result of subsequent butchery of the carcass.

Following slaughter, pigs are normally dehaired or skinned. Again, the data on pig butchery from Table 51 offer little to reconstruct these processes. The presence of charred incisor and canine teeth from one site (San Giovanni) might indicate that pig hair was singed off the body, in a manner described by Takács (1990), but it may also signify that whole animals were roasted. Heat causes the muscles around the front of the mouth to contract, thus exposing the incisor teeth to the fire. Scalding the skin with hot water would loosen bristles allowing them to be scraped away easily while not burning the skin, but such a method would not leave any traces on the bones. Alternatively, butchers may have skinned pigs, and the presence of knife lines on the metapodials and phalanges of pigs from some sites in Table 51 might be related to this process. Generally, the lower leg area is the location where the skin would be initially or ultimately cut from the body.

The front leg of the pig was detached from the rest of the body by chopping somewhere between the neck of the scapula and the proximal end of the humerus, both of which show much evidence of butchery according to the data in Table 51. The remainder of the leg was detached, usually with a cleaver, at the junction of the humerus and radius/ulna, and at the metacarpals. The back leg was likewise disjointed by chopping first around the pelvis or at the proximal end of the femur, and then at the junction of the femur and tibia, and tibia and tarsals/metatarsals. The locations of the chops used to separate sections of the pig's leg do not vary significantly from those of cattle or sheep/goat. The general butchery techniques from all these animals were likely very similar.

In addition to the information about disarticulation of joints, the data from Table 51 indicate procedures of filleting meat. The presence of relatively more chops and knife cuts along the body of the pig scapula indicates the importance of this area as a source of meat, in contrast to that of cattle or sheep/goat. The pig humerus also seems to be the site of much butchery activity, at both ends and along the shaft.

Finally, rural and urban2 sites again record a greater range of butchery marks caused by different types of tools, and at different spots on nearly all parts of the pig skeleton, as opposed to materials available from urban1 sites. Such data suggest a much greater variety in butchery techniques amongst rural and smaller settlement sites than larger cities. The relative dearth of complete pig long bones (e.g., a femur is the only example noted in Table 46) compared to those of cattle and sheep/goats (e.g., complete humeri, radii, femorae and tibiae are noted for these taxa in Tables 26 and 38) supports the hypothesis that pig butchery was more destructive than that for these other consumed domesticates. However, this pattern may also relate to taphonomic differences, since generally pigs were slaughtered at younger ages compared to cattle or caprines. Immature bone is favoured by carnivores and thus tends to fragment more readily than mature bone.

Special Butchery

Bisection of Vertebrae

One butchering technique of particular interest in the bisection of vertebrae. Bisected vertebrae usually indicate that an animal has been partitioned longitudinally, dividing the carcass into equal left and right halves. Although examples of bisected cattle, sheep/goat, and pig vertebrae are noted from a variety of Roman period sites in Italy, and their incidence generally increases through time, these do not occur to any marked degree to suggest that this procedure was commonplace. Moreover, no site produced just bisected vertebrae. The irregular patterning in vertebral bisection, coupled with the co-occurrence of both bisected and whole vertebrae at individual sites, suggests that some of this longitudinal splitting took place after the carcass had been transversally cut into several sections. Of the three kinds of domesticates, cattle show the fewest traces of vertebral splitting, but record some of the earliest dates for its occurrence (e.g., Locri, Cozzo Presepe, Colognola). Bisected vertebrae of pigs and sheep/goat are both relatively and absolutely more numerous that those of cattle.

Horn removal

Horns can be removed in two basic ways. First, the horny sheath can be pried off by manipulating a knife under it, but this would have to be performed while the horn was still on the animal's head, or at least with its basal attachment to the head still intact. This might generate difficulties, especially if materials were to be transported. In addition, one might not wish to move full animals just to remove their horns. The second method to remove the horn is to chop or saw both it and its bony horn core from the head, then later extract the horn from this detached piece. It is often easier to extract the sheaths by soaking them for a period of time. Thus, ideally one would wish to remove the horn and core together. Chopping at a horn with a cleaver or knife might shatter or otherwise damage it, so I suspect that most horns destined to be worked were probably sawn off. However, as noted above, the saw was also used in animal butchery, while horns would have to be removed—again likely sawn off for a clean cut—to process the hide.

The zooarchaeological evidence shows no distinct patterning for horn core removal in cattle or caprines. Some were sawn off, while others were chopped. Several examples display both saw and chop marks on the same horn core. No technique appears to be favoured; in fact, both methods of horn removal co-occur at a number of sites.

Butchery in Wild Animals

Butchery traces are infrequently reported for potentially consumed wild animal species recovered from Roman period sites in Italy. A small piece of bone was gouged, or whittled out of the medial section of a red deer metatarsal from San Giovanni (period 3). Several lagomorph bones from the same site and time period show traces of butchery as well. These included a tibia, which contained two small knife cuts lines on the caudal edge the proximal end, a calcaneum, which showed minute cut marks, and a femur which had its distal end cut with a knife at an oblique angle to remove the lower leg. A red deer phalanx from Lugnano cemetery levels had been chopped at its proximal end. Finally, chop and cut marks were noted on the shaft of a radius/ulna from Late Roman Monte Gelato.

Butchery Location

The archaeological and faunal data from Roman Italy are insufficient to determine, without doubt, the location of butchery areas at sites. There are no examples of rooms showing structural modifications, such as slaughtering tables, scalding tanks, hanging racks, or hooks to identify them positively as slaughter/butchery areas.

(ii) Preservation and Storage

There is no conclusive evidence from the animal bones themselves to determine methods of meat preservation and storage. When meat is smoked while on the bone it adheres more firmly to it and thus has to be scraped off with a knife (Lauwerier 1986: 210). Cut marks are noted on the surface of a number of bones recovered from archaeological sites dating to the Roman period in Italy, but there is no way of determining if these reflect butchering of fresh or smoked meat. Moreover, even if we could discern that these are the result of filleting fresh meat, it is impossible to ascertain what became of this meat after it had been stripped off the bone. Pieces of meat can be smoked just as, if not more, efficiently as meat still left on the bone. No bones from any of these sites had been perforated to assist in hanging a carcass, presumably for drying and smoking, as is shown elsewhere with the examples of pierced cattle scapulae from sites in northern Europe (Lauwerier 1986; van Mensch and Ijzereef 1977; Schmid 1972).

The archaeological evidence does not provide much help in terms of recognizing preservation and storage of meat. No racks, hooks, or other equipment specifically designed to expose meat to sun, wind, and/or smoke have been recovered.[64] Moreover, no vessels, ceramic or otherwise, expressly associated with mammalian meat storage or preservation have been identified from Roman sites in Italy.[65] Most of these could have held any number of substances, and not principally meat. As far as I am aware, chemical tests have yet to determine if Roman ceramic vessels from Italy contained meat or mammalian products such as milk, lard, or blood, even though animal fats, or lipids, preserve well in the archaeological record and can be detected using chemical means.[66]

(iii) Cooking

Reconstructing cooking practices on the basis of animal bone evidence is difficult in that we are limited to procedures where meat was cooked or otherwise treated while still on the bone. It is impossible to determine how meat filleted off the bone was cooked since the bone would certainly be discarded or used for something else. Conversely, there is no guarantee that cooking a piece of meat where the bone is still attached will leave a recognizable trace on the bone. Moreover, there are a number of methods used to cook meat—roasting, boiling, baking, etc.—but they are not equally distinguishable. Roasted or burnt bone is readily marked by discolouration and an "ivoried" or glossy appearance (Pearce and Luff 1994: 51). However, the meat surrounding the bone can protect it from such exposure and prevent any modification. The ends of the bones often show more burning that other parts simply because they hold a greater potential to be exposed to the coals and flames during roasting. Boiled bone may not differ markedly from unboiled bone in its appearance; however, experimental evidence shows that it does disintegrate more readily than fresh bone (Lyman 1994a; Nicolson 1992; Pearce and Luff 1994; among others). Finally, fragmented bone is a typical byproduct of marrow extraction. Normally, the bone is smashed midshaft, leaving a number of spirally-fractured long-bone pieces.

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[64] Although there is conjectural evidence for them. For example, Widrig (1980: 127) speculates that a certain amount of ash detected in the eastern room at the site Via Gabina, site 11, might have been the remains of racks for smoking.

[65] There is, however, much more evidence for containers holding preserved fish (Curtis 1991), and possibly preserved birds. Bones from the brisket of twenty-eight song thrush birds were recovered from a cork urn excavated at the Roman military settlement at Nijmegen, the Netherlands (Lauwerier 1993). Lauwerier (1993: 18) speculates that these briskets were possibly preserved with either salt or honey. Ikram (1995: 157) notes a couple of examples of salt-preserved birds found in amphorae and pots from ancient Egypt, but these pre-date Roman times.

[66] See Evershed et al. (1992), Rottländer (1990), and Rottländer and Schlichtherle (1979) for examples of the detection of animal (and plant) lipids in ancient ceramics. Dudd and Evershed (1998) have recently been able to identify milk fats from Roman pot sherds recovered from several sites in Britain. The procedure has not yet been applied to examine ceramic materials from excavations in Roman Italy.

Zooarchaeological evidence for cooking meat is usually limited to situations where meat had been cooked while still on the bone. Roasting or grilling meat over a fire might burn any exposed section of bone. As such, it is nearly impossible to identify this process in an animal roasted whole on the spit, where perhaps only the front teeth might be exposed and charred. Furthermore, it is not always possible to determine if charring was the result of cooking or if it occurred from some natural fire. Both can leave similar evidence depending on the surfaces exposed and the duration and intensity of the fire.

Bone can also be boiled to extract marrow or to produced broth. Excessive bone fragmentation with spiral fracturing can sometimes be indicative of butchery to obtain marrow. In some cases bones are split along the shaft for the same purpose. However, taphonomic agents such as carnivores and weathering can produce similar or identical fracture patterns, rendering it difficult, if not impossible to separate the results of marrow extraction for cultural purposes from fragmentation produced by post-depositional processes.

Few bones from any of the sites in Roman Italy shows signs which can be positively attributed to cooking. Burnt and calcined bones are noted at a number of sites (e.g., Via Gabina, Monte Barro, San Giovanni, Gravina) but never in quantities suggesting that roasting predominated. Moreover, in many cases, details about the location and colour of the burn marks were lacking, making it difficult to speculate on the probable cause (i.e., natural or cultural). Natural conditions will regularly carbonize bones but will rarely calcine them (Shipman, Foster, and Schoeninger 1984). Calcination requires higher temperatures (over 450° C) or continued heating for over 3-4 minutes. When large proportions of the surface of a bone are calcined, one can safely infer (anthropogenic) thermal alteration under higher temperatures, like in fires. Few calcined bone pieces were reported from the sites in Roman Italy making it hard to draw interpretations. Moreover, the fact that many reports provided no information about burnt or calcined bone need not imply none was recovered, or that roasting never occurred.

Fragmented bone is common at archaeological sites and many of the faunal reports for Roman period sites in Italy commented on its presence with statements such as "strongly fragmented," "very fragmented," "many fragments," and so forth. Some hinted that the fragmentation patterns shown suggested bone breakage for marrow, but in no case could this be proven as the sole contributor. It seems likely for some sites on the basis of chop marks along the shaft of several long bones. According to Tables 49 - 51 these marks are common in the humerus, femur, radius, and tibia of cattle, sheep/goat, and pig, particularly amongst rural sites (e.g., San Giovanni, Settefinestre, Matrice, San Giacomo, Monte Barro), although the butchery data in general are biased in favour of rural sites. A number of cattle metapodials also display evidence of being hit midshaft, again presumably to fragment the bone for marrow extraction. However, many fragmented bones show no trace of being struck with a knife or other sharp tool, thus rendering the agent of fragmentation more ambiguous. Spiral fractures, originally believed to be caused solely by humans, can in fact be caused by other agents such as trampling and carnivore gnawing, and therefore need not always imply cultural modification to bones. As noted in Table 11 many of the sites with "fragmented" samples also reported carnivore activity on the sample of bones, making it impossible to separate natural and cultural agents for fragmentation.

Textual Evidence

Butchery and Preservation

The ancient authors offer only a few clues which we might use to document and reconstruct animal slaughter, butchery, and meat preservation in Roman Italy. The texts are silent on details surrounding animal slaughter, outside of mentioning animals slaughtered for sacrifice. They note three attendants who presided at the public sacrifices -- the *popa*, who stunned the animal with a mallet (Prop. 4.3.62; Pers. 6.5.74; Seut. *Cal.* 32.3), the *cultrarius*, who cut its throat (*CIL* 1.1604; Seut. *Cal.* 32.3), and the *victimarius*, whose role is less clear. He is generally associated with the ax used to sever sacrificial victim's heads, but may have played some part in the purchase of the victim or the disposal of the meat (Plin. *NH* 7.12.54).

The texts provide some information about what happened to non-sacrificial animals after slaughter, namely dehairing and skinning. Columella (12.55.4), claims that the Romans removed pig bristles either with boiling water or a small flame. Cassiodorus (*Var.* 9.6.11) adds that the "usual manner" used to strip hair from an animal is to immerse the skin frequently in boiling water, before cleaning it.[67]

Textual references to the location and procedures involved in butchery are similarly scarce. Plautus (*Trunc.* 2.7.614) hints that lambs are cut up the middle, bisecting the carcass into right and left halves, while he alludes to meat hanging on racks in another reference (Plaut. *Capt.* 4.1.914-915). Lucilius (3.112-113, cf. Aul. Gell. 3.14.8) speaks of a bisected pig with "one eye and two feet," an indication that it was cut through the spine. He also chides the gluttons stripping meat from meat-hooks (Lucil. 2.67-69, cf. Nonius 10.27). Apicius (2.4) mentions sausages suspended while being smoked. The Younger Pliny's villa at Laurentum, 17 miles from Rome (Plin. *Ep.* 2.17) contained a larder for animal processing on the premises, while the author of the *Moretum* (*Mor.* 56-57) laments the absence of a larder at Simylus' abode.

Although efforts were likely taken by the site occupants to consume animals within a few days after slaughter,[68] it is probable that some meat had to be preserved, whether it be meat required during the winter months when food resources were scarce, or meat which was to be transported elsewhere, such as to an urban market. In the absence of refrigeration[69] meat must be preserved in one of several ways, by drying, smoking, salting, pickling, or otherwise coating it to prevent putrefaction. Each of these methods receives reference in the ancient texts.

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[67] I am grateful to Tana Allen for this reference.

[68] Apicius (1.7.1) states that, in the summer, unsalted meat could be kept for only a few days.

Drying and smoking are mentioned in several ancient Roman texts, but without explicit details about the equipment and procedures required. Macrobius (*Sat.* 3.17.9) notes that the Licinian Law of 103 BC restricted meat consumption to no more than 3 lbs of dried meat (*caro arida*) outside of the Kalends, Nones, and market days. Elsewhere, dried meat is mentioned briefly (Aul. Gell. 2.24.7; Paul *Dig.* 49.14.50). Smoked meat is also only expressly documented in a couple of sources (smoked pig's cheek [Pers. 6.69-73]; smoked sausages [*Ed. Diocl.* 4.15-16]). Cato (*Agr.* 162.3) writes of smoking meat, but only after it had already been preserved by salting.

There are plenty of references to salted meat in the texts (Col. 12.55.1-4; Cato *Agr.* 162.1-3; Pallad. 13.6; Mart. 1.41, 7.54; Calp. Ecl. 5.24-28; Macrob. *Sat.* 3.17.9, 7.12; Pers. 6.70; Hor. *Sat.* 2.2.117; Strab. 3.4.11, 4.3.2, 4.4.3; *Ed. Diocl.* 4.7; plus Apicius). Columella (12.55.1-4), Cato (*Agr.* 162.1-3), Macrobius (*Sat.* 7.12), and Apicius (1.8-10) describe the procedures involved in salting meat (generally pork, and mostly boned as per Columella [12.55.1]). They mention a process whereby pieces of meat are packed closely together in layers inside a large tub, jar, or pot (Cato [*Agr.* 162.1-3] calls these vessels *seria*) and salt is put between each layer. Cato (*Agr.* 162.2) claims that this meat and salt mixture should remain for five days after which the pieces are removed then put back into the container in reverse order (i.e., top pieces now at the bottom) and allowed to sit for twelve more days. Following this, the pieces are taken out, the salt brushed off, and the meat hung to dry for three days. At this point the meat is cleaned with water, rubbed with oil, hung to be smoked for two days, and finally rubbed again with oil, before it is ready for consumption or storage.

Columella (12.55.2-4) mentions another method for salting meat. Pieces were covered with salt, arranged on a board, and weighted on top to press out the blood. More salt was added after three days, and then daily for nine to twelve days afterwards. Following this the meat was washed, and finally hung and smoked in order to dry completely.

Large amounts of salt are needed for salting. Cato (*Agr.* 162.1) advises a half-*modius* (c. 3.5 kg) for each ham (dry curing). However, salt was also expensive and consequently of great value. Cassiodorus (*Var.* 6.7.8) equates the value of salt with that of silk and pearls, while Pliny (*NH* 31.41.88) claims that "civilized life is impossible without salt."

Finally, Apicius (1.7.1-2) notes two other techniques for preserving meat: pickling, and covering with honey. He provides a procedure for home pickling of pork and beef skins and cooked trotters (Apic. 1.7.2), presumably with salt and vinegar, although specific ingredients are not given. In the other method, meat is coated with honey (Apic. 1.7.1-2).

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[69] A couple of Greek references note the use of snow to keep meat cold (Plut. *Quaest. conv.* 6.6.1.3; *Geoponika* 19.9.2), but there is no mention of this in the Latin texts. Nevertheless, I expect this technique was used in areas which had snow, especially in the northern Italian Alps.

This procedure does not seem to be as routinely practiced as salting or smoking, and was considered more valuable for winter storage (Apic. 1.7.1-2) when presumably the honey would not melt off and expose the meat, or attract insects and other pests.

Butchers

Slaughter and butchery not carried out on the farm by landowners, slaves, and farmers, was generally in the hands of *lanii*, *macelarii*, and various wholesale merchants (*negotiatores*). Since these individuals were the intermediaries between the rural producers and the urban consumers it is not surprising to find that they were variously organized into *collegia* or other associations, from at least the time of the late Republic (*CIL* 1.2.978, 6.167; Frayn 1996; Waltzing 1895-1900, 26,8).

Although there is some confusion as to the exact definition of *lanius* and *macellarius*, the former generally refers to a slaughterer of animals or a butcher, while the latter denotes a market trader of meat (*lanius*: Plaut. *Capt.* 818; Liv. 3.48.5; Mart. 7.61.9; Varro *Rust.* 2.4.8, 3.2.11; Col. 7.3.13; *macellarius*: Varro *Rust.* 3.2.11; Cic. *Fam.* 15.17.2; see also *Oxford Latin Dictionary*; Frayn 1996: 107-108). The difference between these two terms is marked by Varro (*Rust.* 3.2.11) when he questions if a landowner gets more from the *lanius* for the pigs raised on his farm than another individual gets from the *macellarius* for the wild boars from his estate. Before they could be sold, the pigs had to be slaughtered by the *lanius*. The wild boars, however, avoided this step since they had presumably already been killed during a hunt, and merely had to be prepared and sold in the market by the *macellarius*. Specialized terms such as *porcinarius* (dealer in pork, *CIL* 6.33900), *pernarius* (dealer in ham, *CIL* 6.31120), *suarii* (dealers in swine, *CIL* 6.1693) and *confectorarius* (dealer in dried pork, *CIL* 6.9278) seem to replace the word "*lanius*" in the 3rd and 4th century AD (Loane 1938: 291).

Butchers, or *lanii*, had shops, *lanienae*, and equipment to carry out their tasks. Plautus (*Epid.* 199 or 2.2.15), Varro (*Ling.* 8.55; *Sat. Men.* 456), Tertullian (*De anim.* 33.3), and Livy (44.16.10) all refer to *lanienae*. Most animals were probably brought into these shops or stalls already killed, as noted by Varro in the passage above (Varro *Rust.* 3.2.11). Some, however, may have been slaughtered at the premises (Liv. 44.16.10), presumably on a *lanionius*—a butcher's table or board (Suet. *Claud.* 15.2). Apparently some butchers could not be trusted. Plautus (*Capt.* 4.1.818-200) scorns those deceitful butchers who sell older sheep claiming them to be lamb, or who pass off tough ram as prime wether. Theirs was not a favoured occupation (Terence *Eunuch* 2.255). Martial (6.64) comments on the "cruel" butcher who, of all people, could carry the bloody animal carcass from street to street. Moreover, he debases the salt-meat sellers and sausage cooks (Mart. 1.41). Although butchers are not mentioned in the Edict of Diocletian, tradesmen with similar occupations such as bakers and blacksmiths received a relatively modest maximum wage of 50 *denarii* per day compared to other professional workers (*Ed. Diocl.* 7.11-12).

Cooking

According to the ancient texts, the Romans cooked meat in five basic ways:

- boiling - either alone or, more commonly, as part of a stew
- roasting

- frying
- grilling
- baking - such as in a casserole

Apicius is our most detailed source of such information.

Boiling and roasting are the most popular of all these cooking methods. Varro (*Ling.* 5.109) confirms this in his chronological ordering of techniques—roasting, boiling, and stewing—which seems also to correspond to contemporary popularity (Corbier 1989: 234). Apicius lists over 50 recipes which require boiled meat (some of which are actually recipes for sauces to put on these boiled dishes), and over 40 recipes calling for roasted meat. The inventory is extremely diverse. Boiled and stewed meats range from boiled udder (Apic. 4.2.14-15, 7.2.1-2) to ham (Apic. 7.9.1-2) to venison (Apic.8.4.2). Roasted dishes incorporate the likes of *ofellae*, or pieces of meat (Apic.7.4.1-2), suckling pig (Apic.8.7), and hare (Apic.8.8) to mention a few. Apicius' attention to boiled and roasted meats agrees with the writings of Celsus, who notes that meat is best eaten when roasted or boiled (Cels. 1.2.8) - roasted meat being easier on the stomach (Cels. 1.3.24). Celsus suggests that people vary both their cooking styles and meat consumption according to the seasons (Cels. 1.3.34-35). During winter one should eat a lot bread, few vegetables, and a modest amount of meat which is preferably boiled. In spring, meat and vegetable consumption is increased, passing gradually from boiled to roasted dishes. Finally, he suggests most summer meats be roasted. Roasted meat was believed to be digested slowly (Celsus 1.6.2).

The army also consumed boiled and roasted meat. There are even references to army generals passing orders that these were the only methods by which troops could cook their meat (Appian *Iberica* 85; cf. Frontin. *Str.* 4.1.1-2; Polyaenus *Strategmata* 8.16.2), although these describe battles outside of Italy.

Frying, grilling, and baking meat (such as in a casserole) receive far fewer references amongst the ancient texts than boiling and roasting. Each is listed less than ten times in Apicius' recipes. Frying and grilling generally call for *ofellae* (Apic. 7.4), selected organs like liver (Apic. 7.3.2) and kidneys (Apic. 7.8.1), or smaller animals such as hare (Apic. 8.8). Frying, however, seems to have been more commonplace amongst cereals and legumes than meat (Corbier 1989: 234). Baked meat dishes include suckling pig (Apic. 5.4.6, 8.7.16) and sausages (Apic. 5.3.8).

The key to cooking luxury seemed to be diversity in both methods employed and taste. Sidonius Apollinaris (*Epist.* 2.9.6) recognizes how a senator's meal is varied by having some meats roasted and others stewed. Sausages were perhaps the most versatile food since they could be boiled (Apic. 4.2.13; pseudo. Virgil *Catalepton* 13.30-31), stewed (Apic. 4.5.1, 5.3.2), baked (Apic. 5.3.8), grilled (Apic. 5.3), fried (Apic. 7.4), or used as an ingredient in stuffing for other meats (Apic. 5.4.6). Such culinary diversity may have added to their popularity during Roman times.

Variety in taste was achieved primarily through sauces. Boiled meat in particular would have been somewhat bland. It's taste could be revitalized, or disguised, by sauces.

Apicius lists a number of sauces for boiled meat (Apic. 7.6.1-14) many of which include the highly pungent fish sauces: *garum, allec, muria,* and *liquamen*. Such strong sauces certainly changed the original taste of the meat radically.

Besides listing ingredients, some recipes of Apicius provide details about boning, chopping, and otherwise preparing meat to be cooked or preserved at the household level. In one recipe he tells people to soak pieces of meat in water (Apic. 7.4.6) prior to cooking, presumably to remove some of the salt. The salty taste of salt-preserved meat might also be reduced by first cooking the meat in milk then in water (Apic. 1.8).

Apicius refers on several occasions to boning meat. Boned suckling kid or lamb (Apic. 8.6.6), suckling pig (Apic. 7.10, 8.7.14, 8.7.16), and boned hare (Apic. 8.8.6-7) are ingredients in several recipes. The fact that he tells the reader to bone them suggests that at least these animals could be purchased whole, or at the minimum with bones still inside. In some cases, boning was required before the meat could be preserved. "Remove the meat from the bone after boiling" he instructs in one procedure for curing pork (Apic. 7.10). In two other references, suckling pig (Apic. 8.7.16) and hare (Apic. 8.8.7) were boned prior to hanging the pieces of meat up to be smoked.

Although the ancient Romans knew how to cook and preserve meat, there were still cases when rancid meat was served. Horace (*Sat*. 41-2) and Cicero (*In Pis*. 67) both make reference to rotten meat in a dinner context.

Integration

The information about animal butchery, meat preservation, and cooking given by the zooarchaeological and textual records only occasionally overlaps, which makes their combined analysis essential, in that both sources are required to develop a fuller understanding, but also complicated, since neither can test the accuracy of the other to any great degree. The zooarchaeological record tells us much more about the equipment, procedures, and patterning involved in carcass butchery. The texts, however, reference aspects of meat preservation and cooking more than they provide information about the actual mechanics of animal slaughter and butchery.

Butchery

Although there are potentially many ways to slaughter and butcher an animal, the ultimate goal remains the same: convert the living animal into a consumable commodity. A number of factors will influence the method chosen. These include available technology and time, animal size and shape, number and skill-level of butchers involved, as well as the nature, location, and demands of the consumer (e.g., wealthy or poor consumer, sacrifice or regular consumption, locally consumed or exported, etc.). The variation in butchery patterning as revealed in the animal bone can provide information about these aspects. For example, in disarticulating a skeleton, the placement of the bones often dictates where chops and cuts are to be made. Usually animals are partitioned at their joints, or between bones. A preponderance of relatively less efficient chops and cuts made outside of these zones, however, requires explanation, since it deviates from the normal pattern. Possible explanations include an unskilled butcher, a different type of consumer demand, etc. The analyst must consider all evidence to obtain the more probable solution(s).

Combined faunal and textual data tell us almost nothing about animal slaughter and butchery in Roman Italy, although both may have been common events at the household level in terms of meat preparation for the table.[70] References to animal sacrifice, however, form an exception. Here, the texts mention first stunning the victim with a mallet (Prop. 4.3.62; Pers. 6.5.74; Seut. *Cal.* 32.3), then slitting its throat (*CIL* 1.1604; Seut. *Cal.* 32.3). Although the texts are not explicit, it seems likely that a similar procedure was applied to non-sacrificial animal slaughter as well.

A few faunal remains provide speculative evidence for animal slaughter. Chop and cut marks occasionally feature on neck vertebrae of cattle, sheep/goats, and pigs, which may indicate that their throat was slit. However, such marks could also be related to the subsequent butchery of the mammal. The data are inconclusive. Animal slaughter does not really involve any fundamental transformation of the skeleton or of the natural form of an animal (Peck 1986: 163). Given this fact, I assume that Roman mammals in Italy were generally slaughtered in a way(s) which left no recognizable osteological traces. Identifying consistency amongst slaughtering methods practiced in Roman Italy is impossible on the basis of present data; however, I would expect little temporal or regional variation, and a similar methodology for all mammals, regardless of size. Most were probably herded into a confined space or somehow brought to the ground, stunned, slit at the throat, and bled to death.

The first step in animal slaughter is to render the beast motionless so that it can be killed without causing injury to the butcher. This can be achieved in two basic ways. In the first method the animal can be herded into a confined space, preferably one where it would not be capable of turning around. Peck (1986) mentions driving an animal into a small stall where its head would protrude. Alternatively, the animal might be lassoed, wrestled to the ground and trussed, reminiscent of rodeo tactics. Larger animals such as cattle could be tripped by tying their legs together, then secured after the fall by binding the remaining legs. Smaller animals, such as calves, sheep/goats, and pigs might simply be wrestled to the ground and then held down prior to slaughter.

As noted above, Roman sacrificial animals were stunned before having their throats cut, and such a procedure is suggested for non-sacrificial victims as well. Modern butchers tend to stun, shock, or pith[71] beasts thus rendering them unconscious or immobile prior to slaughter. Any type of club or hard instrument might be used. Rixson (1989: 55) notes the use of a hammer to stun cattle and a large wooden ball on the end of a handle to stun pigs. Stunning, shocking, or pithing an animal serves a dual purpose. First, it is a more humane method of butchery. Second, it enables the butcher to cut the throat more easily, without fear that the animal will move uncontrollably. Moreover, he could perform the duties with fewer assistants if less help was needed to hold the beast down.

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[70] Slaughter and butchery for those of Jewish faith, however, likely held greater esteem than such activities did for other religions with less stringent codes concerning meat consumption.

[71] In 'pithing' a metal rod is inserted into the animal's head which immobilizes the neural system.

A butcher usually kills the animal by severing the carotid artery and jugular vein in the throat thereby causing profuse bleeding. After the animal's throat has been slit the carcass is drained of blood. Blood taints the taste of meat, so it is necessary to remove it. The constriction of blood vessels in the dying animal will effectively pump out much of its blood from the body after the throat is cut (Warriss and Leach 1978), but blood is most efficiently discharged from a hanging carcass since this method can also take advantage of gravity in drainage. Although it seems probable that carcasses were also hung to drain blood in Roman times, neither zooarchaeological nor textual evidence can prove this. Modern-day butchers use chains, ropes, and pulleys to hoist animals. Similar systems may have been employed by the Romans. The carcass would be lifted by its back legs so that the blood would drain from its neck presumably into some type of container. Blood, being considered vile, was not normally consumed in antiquity, and in fact prohibited by legislation, presumably from a early time (*CJ* Const. Leo 58). Some people, however, still used it in making certain dishes such as blood sausage. The rise of Christianity likely prompted the Emperor Leo to enforce stricter legislation against the sale and consumption of blood, with severe penalties, including exile, imposed on transgressors (*CJ* Const. Leo 58).

While hanging a carcass is certainly an efficient way to drain blood, it is not the only method. Depending on a number of factors such as the shape and surface area of the operational space, the technology adapted, and the type of animal being slaughtered, a butcher might place the animal on a table or butcher's block with its head over the edge to bleed. Alternatively, the animal might be placed on the floor or atop a table and the blood drained from its body by pumping its foreleg. Although not currently practiced in Italy,[72] nor referenced in the ancient texts or depicted in Roman art, this action is shown in several Egyptian reliefs and paintings,[73] and still performed in some parts of the Middle East and Eastern Europe into the twentieth century (Ikram 1995: 46).

Following slaughter and draining of blood, pigs are normally dehaired or skinned, while cattle and caprines are generally skinned. As mentioned earlier, Columella (12.55.4) and Cassiodorus (*Var.* 9.6.11) note the use of boiling water and small flames in removing pig bristles. Fire will burn bones and the presence of charred pig incisor and canine teeth from the site of San Giovanni might indicate that pig hair was singed off the body, but it may also signify that whole animals were roasted. Scalding in a tank of water would loosen bristles allowing them to be scraped away easily while not burning the skin. It might have been practiced amongst some Roman period sites in Italy, but there is no corroborating archaeological evidence. There are examples of fulling tanks at some sites which, aside from cleaning and dying sheep wool, might also have been used in dehairing pigs. Scalding in a large tank, however, is only economical if many pigs are treated at one time. A bucket or tub of boiling water might suffice for just a few individuals. Alternatively, butchers may have skinned pigs. This process might leave knife lines on some bones, especially the phalanges (i.e., toe bones) where the skin would be initially or ultimately cut from the body. A number of sites listed in Table 51 record cut and chop marks on the lower leg bones of pigs, but it is unknown what percentage relates to skinning or is part of the subsequent butchering of the carcass.

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[72] At least not in modern facilities. Alastair Small (personal communication) witnessed the slaughter of a sheep on a table near the site of San Giovanni di Ruoti in the mid 1980s. However, it is not known if the blood from it was subsequently "pumped" from the body in the manner described above. Franca Boag (personal communication) did not notice this technique being used during her recent ethnoarchaeological study of farmers in southern Italy.

[73] Ikram (1995) gives an example of an Egyptian painting which shows butchers "pumping" cattle forelegs to drain the body of blood.

Osteological evidence for skinning other animals from Roman period sites in Italy is perhaps more certain. For example, sheep/goat metapodials as listed in Table 50 often exhibit relatively more knife cuts than other sheep/goat bones, while the lack of butchery marks on their phalanges suggests that the lower feet were discarded whole and that skinning of the animal did not proceed down over the rest of the foot. Caudal vertebrae are scarce in all deposits, although they are also very small and not easily recovered. Nonetheless, their absence suggests that animal tails were removed with the animal skins, and presumably eventually discarded with tanning and hide processing waste rather than butchery and consumption waste. A similar situation might explain a scarcity or absence of horn cores from a deposit which otherwise contains bones from the rest of the animal skeleton. These horns may have been removed either with the hide or on their own for some other purpose (e.g., glue manufacture, horn working). The massive cattle horn core deposit at Aquileia offers proof that horns could be treated differently than the rest of the carcass.

Some wild animals were also skinned. Settefinestre, a large, rural villa site in Tuscany, contained a collection of deer bones, predominately crania and lower foot bones, which was concentrated in a small courtyard (King 1985: 284-285). The scarcity of deer bones excavated elsewhere from the site suggests that this special deposit was associated with the initial removal of deer pelts for processing.

While there is some zooarchaeological and textual evidence to support skinning and/or dehairing Roman animals, many specifics about these procedures remain obscure. We do not know if animals were skinned while suspended or supine. Ikram (1995: 49) notes that in ancient and modern Egypt, larger mammals such as cattle were flayed chiefly on the ground but at times while hanging.[74] Smaller mammals (caprines and gazelles) were normally skinned while suspended. She notes that it is easier to flay a suspended carcass than a recumbent one (Ikram 1995: 49). In a hanging carcass, the butcher can readily access the whole of the animal without shifting it and flipping it over as is required with a recumbent carcass. Moreover, the skin can be cut and pulled from the body with trouble spots quickly identified and compensated for in a raised carcass. Younger animals are normally easier to skin then mature ones. The connective tissue holding the fleece in a lamb, for example, is undeveloped so the skin pulls away easily. However, this tissue is developed in a mature ewe or ram and must be cut away (Peck 1986: 96).

We also do not know if the skinning procedure began with a certain leg or on a certain side of the body. In ancient Egypt, skinning usually started at the right hind leg on the basis of artistic evidence (Ikram 1995: 49). The back legs were skinned first followed by the torso and finishing with the front legs. Whether or not the Romans practiced a similar procedure cannot be determined. However, to utilize gravity effectively and optimize viewing it is logical to begin skinning a hanging carcass at its hind legs (which are suspended) then work down over the belly to its front legs (which dangle below).

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[74] Full-grown, large cattle are flayed on the ground. The initial incisions and steps for skinning smaller-sized cattle and calves are performed with the animal on ground but it is later hung from its hind legs to finish the procedure (Ikram 1995: 49).

Most mammals are gutted following skinning, although in some cases the order is reversed and they are gutted after slaughter but before skinning. In gutting, the butcher makes an incision from just below the genitals down over the belly, then reaches in to remove the entrails. Whether or not these materials were consumed, however, depended on the context. In Roman animal sacrifice the *exta* —which included the liver, lungs, spleen, and heart (the latter only after 260 BC according to Pliny [*NH* 11.186])—was offered to the gods. A few other pieces were added to them (Varro *Ling*. 5.112) and the offering usually burnt on the altar. The rest of the carcass, collectively known as the *viscera* (Serv. *Aen.* 6.253) was eaten by the sacrificer and his guests in the cult. In normal butchery, the entrails were sorted into their component parts—liver, heart, lungs, kidneys, intestines, etc.—presumably all of which were eventually consumed. Apicius provides recipes involving kidneys (Apic. 7.8), liver (pig's: Apic. 2.1.4, 7.3; lamb/kid: Apic. 7.12.1; hare's Apic. 8.8.5), stomach (Apic. 7.7.1-2), womb (Apic. 2.3.1, 7.1.1-6), udder (Apic. 7.2.1-2), bladder (Apic. 8.7.1), while intestines and omentum[75] were frequently used to encase sausages or other mixtures (Apic. 2.1.7, 2.2.2, 2.4, 2.5.1-4, 7.3.2, 7.16.2, 8.6.11, 8.8.8). Animal heart and lungs are never specifically mentioned in a culinary context, but assumed to have been eaten. Any part of the animal entrails not consumed by the Romans themselves was probably fed to other animals such as pigs or dogs.

Even animals destined to be consumed whole were normally gutted before being cooked. Apicius (8.6.11, 8.7.1-5, 8.7.16, 8.8.6-9) usually instructs his readers to either remove all the entrails or at least disembowel the animal prior to roasting or baking it whole. In many cases the cavity is filled with some type of stuffing or sauce. Where Apicius is not specific about gutting an animal, the practice is assumed. Contemporary butchers generally gut all animals, regardless of the manner in which they are to be cooked and served. Ikram (1995: 52) indicates that there are good micro-biological reasons for this practice. The visceral contents will infect the body cavity if not removed after the animal is killed and the intestines cut. Of all the entrails, the intestines especially must be thoroughly cleaned before they can be cooked and eaten.

After an animal has been skinned and gutted, the butcher usually divides the carcass up into joints of meat for consumption. In mammals this procedure is referred to technically as "jointing," but it is often enveloped within the general heading of "butchery." The fact that the ancient Latin authors names various joints of meat such as ham, hock, and so forth implies jointing, but the texts themselves supply almost no information about the methods involved, other than a couple of references to bisecting lamb and pig carcasses (Plaut. *Trunc*. 2.7.614; Lucil. 3.112-113, cf. Aul.Gell. 3.14.8). Any number of reasons might explain this -- from aversion to report these unsightly activities, to ignorance of the procedures involved, to limited demand for such information, to it being so common that it need not be disseminated, to speculate on just a few.

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[75] The omentum is the fold of the peritoneum connecting the stomach with the other viscera.

In contrast to the texts, the zooarchaeological data provide much information about mammal butchery in Roman Italy. Overall the bone evidence shows a fairly standardized methodology, at least for the three principal domesticates: cattle, sheep/goats, and pigs. Cleavers and choppers appear to have been the instruments of choice for most procedures.[76] Chop lines are noted on practically every element of the cattle, sheep/goat, and pig skeleton. The low incidence of saw lines suggests that this tool was rarely used. Available evidence shows that it was principally appplied to remove horns and antlers during early periods and only began to be utilized in carcass dismemberment to any noticeable degree during Late Antiquity. Even then, however, saws were still very infrequently used, likely accounting for less than 5% of dismemberment operations (aside from horn and antler removal). Cut marks on bones are relatively common, but they generally indicate filleting or skinning procedures and not the disarticulation of joints.

Although the butchery evidence suggests that the Romans in Italy practiced a fairly standardized methodology for dismembering animal carcasses, it is difficult to determine the order of procedures. There are no step-by-step instructions. The normal practice for cattle and sheep/goats today is to remove the forelegs first, followed by the head, then the hind legs. With the feet and head detached, the butcher usually next concentrates on the torso, back, and belly, dividing the vertebral column, ribs, and fore- and hindquarters into more convenient and manageable segments. The vertebral column and sternum are usually bisected, thus splitting the carcasses into left and right halves. The butcher then continues to joint the carcass, one half at a time. He first removes the neck. The lower ribs of the animal are next cut off, followed by the forequarter (scapula and humerus top). The butcher then detaches the upper parts of the ribs, and the remaining part of the axial skeleton before finally jointing the hindquarters (pelvis, femur) and tibia. The purpose of this primary butchery is to divide the carcass into chunks which are then further reduced into smaller joints of meat, trimmed and filleted, in what is referred to as secondary butchery.

The butchery order for pigs differs from that of cattle and sheep/goats in that a smaller number of operations is required. The primary difference is that pig's feet are edible, unlike those of cattle and sheep/goat, and are thus left attached to the skeleton over a comparatively longer period. In the initial steps the head is usually detached, although in some cases it remains attached during butchery, and is split in half along with the rest of the vertebral column (Peck 1986: 283). After the spine is bisected, the legs are removed.

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[76] It is not my intention here to discuss the various types of knives, cleavers, choppers, blades, axes, saws and other implements in the Roman butchery tool-kit. Examples of all of these instruments are known from some archaeological sites, but excavators generally recover rather scrappy iron blades, if any tools at all. Butchery took-kit evidence is therefore largely inferred from the marks left on the bones rather than the actual tools. For this reason, I concentrate on these marks and their relation to the butchery technology and methodology. Ikram (1995) discusses tools in the ancient Egyptian butchery kit, which likely shares many similarities with those from Roman period sites in Italy. Grant (1987) provides examples of iron knives, cleavers and saws found from sites in Roman Britain. Presumably these formed part of the butchery tool-kit there. Iron blades have been recovered from a number of sites in Roman Italy (e.g., San Giovanni), but in most cases it is not known if they were used in butchery or for some other purpose(s).

The back legs are detached by chopping or sawing across the pelvis or at the pelvis-femur articulation, while a chop either at the distal articulation of the scapula or the proximal end of the humerus serves to separate the front leg from the body. The ribs, belly, and legs of the pig are further butchered and trimmed into various cuts of meat such as the blade, spare ribs, loin, ham, and so forth.

That most of the butchery evidence for Roman Italy comes from rural and urban2 sites is significant because it indicates that these types of sites were more apt to slaughter, butcher, consume, and dispose of animals all within a relatively small area. In other words, every step of the slaughter-consumption-disposal continuum was conducted either within or very near the site. Slaughtering and butchery of all mammals (and probably all animals for that matter) at rural sites in particular likely took place in a single area, perhaps inside the structure, but surely away from residential sections considering the offensive noises and smells involved in these processes. The Younger Pliny's villa at Laurentum contained a larder for animal processing on the premises (Plin. *Ep.* 2.17). Although it cannot be proven, the impression is that this was a separate structure "on the premises" and not just a converted room within the villa. The argument for this larder being a separate structure is supported by a reference in the *Moretum* (*Mor.* 56-57) which mentions that Simylus' villa lacks a larder. Presumably, animals would still have to be slaughtered and butchered at Simylus' abode to provide for the villa occupants, and in the absence of a specialized larder, carcasses may have been processed in a more generic room at the villa. It is difficult to pinpoint slaughter/butchery rooms in the archaeological plans for the rural sites used in my analysis since no rooms showed structural modifications such as slaughtering tables, scalding tanks, hanging racks or hooks, to identify them positively as slaughter/butchery areas. Moreover, such rooms would be indeterminate if they served a variety of purposes and were not strictly modified for slaughter and butchery in particular. Nevertheless, considering the heavy weight of some bone pieces is seems probable that occupants did not transport bone waste very far, and chose, therefore, to slaughter and butcher animals close to a disposal area. It is possible then that those rooms nearest the greatest concentration of bone waste served as slaughter/butchery areas.

The preponderance of butchered bones at rural and urban2 sites not only provides clues about the process and methodology but also allows us to judge more effectively the skill-level and efficiency of the butcher(s) involved. Peck (1986) noted variation in butchery patterns between large and small-sized Roman villas in Britain. He concluded that smaller villas generally show a more extensive and variable ad-hoc butchery program, which is performed by individuals with limited knowledge of animal anatomy or butchery efficiency. They would sometimes use very energy intensive policies such as using a cleaver when a knife would have been better, all of which suggests that the purpose of butchery was to satisfy limited and immediate consumption (Peck 1986: 188). Moreover, the small-scale villa consumer may not have been too concerned with achieving butchery finesse if he only prepared animals, and principally older and poorer quality individuals at that, on an inconsistent basis. To him, butchery may have been nothing more than a necessary action to package and prepare the meat for quick consumption or storage, as opposed to a more complex method to create the best cuts with the least effort and damage to the carcass. In contrast, the butchery pattern shown at larger villas was less variable than that at smaller villas. In some cases a highly consistent pattern was displayed, indicative of a more organized and standardized procedure. Because they were either better trained or more experienced, butchers here chose more cost-effective strategies; examples of their cuts reflect both anatomical knowledge and appropriate tool choice. The assumption is that this more professionally butchered meat from these larger villas was designed for market or some more intensive basis rather than just immediate subsistence (Peck 1986: 190).

Broad generalizations about butchery efficiency are dangerous, especially when these are based upon a small sample of butchered bones. Therefore, I shall only discuss this for a few sites: San Giovanni, Monte Barro, and Settefinestre.

The variability in both location and frequency of cut and chop marks on the San Giovanni bones reflects a relatively inferior level of anatomical knowledge, and associated ignorance on how precisely to operate the knife or cleaver/chopper during butchery. As a result, the butchers at San Giovanni, in a variety of cases, adopted the least desirable and most labour-intensive butchery option, such as chopping directly through an articulation, or using a cleaver where a knife would have been easier. This is particularly evident in the San Giovanni cattle remains. Bones from this animal seem to have been chopped, cut, and sawn at a number of different areas along their surface and at many different directions and angles on the shaft. Sheep/goat skeletons show much less variability in butchery patterns, while pig butchery seems to be the most uniform of all three principal domesticates. It would appear that butchers were most experienced with the anatomy of the pig, a logical conclusion given that this animal was the one most frequently killed, and the primary provider of meat to the diet. Butchers simply had many more pig carcasses with which to practice and perfect their technique. The possibility that greater standardization and efficiency in pig butchery at San Giovanni relates to market demand finds favour in light of other evidence for massive pig production at this site.

In contrast to San Giovanni, both Monte Barro and Settefinestre record a relatively higher frequency of bisected vertebrae, which suggests a more standardized butchery scheme. Evidence is limited at Settefinestre, but that from Monte Barro shows a fairly uniform and relatively efficient pattern to caprine and pig butchery in particular. These carcasses were split in half including the cranium and mandible from which the brain and tongue, respectively, may have been extracted. On the basis of this evidence it seems that a more efficient butchery pattern was employed at Monte Barro, compared to San Giovanni at least. However, more details—presently not available—are needed to draw definite conclusions.

Without specific information about the variation in location, frequency, angle, and depth of the butchery marks on bones from urban sites, little can be determined regarding the skill-level and efficiency of the butcher(s) involved. We might expect more standardized and efficient butchery procedures in urban settings considering this was normally conducted by professional butchers, some of whom were even organized into guilds (*CIL* 1.2.978; Frayn 1996; Waltzing 1895-1900, 26,8) or certainly experienced enough to attempt deceit (Plaut. *Capt.* 4.1.818-200) with hopes of not being caught. A more standardized butchery scheme at the urban site of Carminiello is suggested on the basis of evidence for bisected carcasses; however, there are also unbisected vertebrae from this site so really no conclusive evidence. A similar situation applies to other urban sites with some butchery information such as Naples-Girolamini and Naples-S. Patrizia.

In the absence of archaeological evidence from any of the sites used in this thesis for hooks and racks on which to suspend the carcasses, it is suggested that animals were generally slaughtered and butchered on tables. While resting a carcass on a table does not facilitate the drainage of blood, it does provide a firm surface on which to chop or cut the animal into pieces. In addition, in a hanging carcass it would have been important to keep the skeleton with its ligaments intact until the bulk of the meat had been removed, otherwise the carcass would fall apart and shift off balance, which could prove dangerous to the butcher if pieces were to drop on him. Resting the carcass on a table would allow the butcher to cut and chop off the meat by manipulating the tools at all angles, rather than in primarily a downward motion as would be convenient for a hanging carcass. Furthermore, he could remove meat and joints from a carcass resting on a table in a variety of ways without the hazard of upsetting the balance or prematurely dismembering joints on a hanging carcass.[77]

The evidence for vertebral bisection in Roman Italy is mixed. Bisected vertebrae usually indicate that an animal had been partitioned longitudinally, dividing the carcass into equal left and right halves. The normal practice today, splitting the vertebrae became increasingly common from the Middle Ages on (Peck 1986: 186; Grant 1987: 56). It relates to a growing degree of professionalism and standardization in butchery procedures probably directed for a market oriented economy (Peck 1986: 196). The comments by Plautus (*Trunc.* 2.7.614) and Lucilius (3.112-113, cf. Aul. Gell. 3.14) indicate that this method was used during the Republican period in Italy. However, its prevalence is difficult to estimate, even when the zooarchaeological data are added. A few Republican period sites such as Locri, Cozzo Presepe, Colognola, and Pozzuolo del Friuli register bisected vertebrae, but the data are limited. That most of these are urban-type settlements might suggest that vertebral bisection was restricted to larger sites where a greater number of animals might be butchered compared to smaller rural sites. In support, the bisected carcasses noted by Plautus and Lucilius were certainly ones viewed in an urban context.

Of the three kinds of domesticates, cattle show the fewest traces of vertebral splitting. Apparently cattle vertebrae were better packaged for consumption as relatively whole bodies, cut transversely so that individual or small groups of whole vertebrae were formed. Pigs and sheep/goats, however, seem to be more important marketed meats, since examples of their bisected vertebrae are relatively numerous. In addition, perhaps the smaller size of caprine and pig carcasses afforded the butcher the opportunity to experiment with different methods of partitioning and sectioning them.

Although there are too few examples of bisected animal vertebrae amongst the Roman period sites in Italy to suggest that this procedure was commonplace, their incidence does increase over time. Furthermore, a greater proportion of rural sites shows evidence of bisected vertebrae, especially during Late Antiquity. Whether or not this is due to technological advancement (i.e., use of saws and heavier, better tools), increased methodological standardization, changed preferences, or somehow relates to enhanced rural-urban linkages (i.e., where rural sites are providing more butchered carcasses for urban sites) cannot be confirmed. No doubt many factors contributed.

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[77] Alastair Small (personal communication) observed the butchering of a sheep on a table in rural southern Italy. See note 99, above.

Combined faunal and textual information does not help to clarify issues of where and how meat was slaughtered and butchered in towns. The recovery of bones from all parts of animal skeletons at most of the urban sites suggests that at least some whole animals were originally available. It is difficult, however, to determine how this was conducted. There are several possibilities. First, animals could have been slaughtered outside the city and transported within as either entire carcasses or butchered parts of a whole animal. Second, animals might be herded into the city and subsequently slaughtered and butchered at the *laniena*, or butcher's shop. Third, animals might have been brought into the city and perhaps raised or fattened for a period of time inside special folds or stalls before being slaughtered and butchered at the *laniena*. Finally, animals may have been brought, either alive or dead, into towns and sold directly to consumers, thereby bypassing urban butchers altogether.

Working backwards through these possibilities, we have no unequivocal evidence to prove or disprove that animals destined for urban consumption bypassed butchers. This would really depend on the degree to which urban dwellers maintained personal links with rural producers. A resourceful landlord, residing in town, might choose to eat animals from his own country farm(s). The agricultural writers encourage frugality and self-sufficiency (e.g., Cato *Agr.* 10-11; Varro *Rust.* 2.4.3; Col. 1.2.3-5). Thus, no doubt some meat moved directly from producer to consumer if convenient for all involved. On the other hand, butchers might be the only agents who provided meat to townsfolk without ties to the country, including the bulk of urban artisans and plebeians.

Bones and texts also provide little information to determine if animals destined for slaughter were raised for any period of time within a city. Several examples of animal stalls or folds linked to houses or shops exist amongst the archaeological remains of Roman urban sites; some of these stalls do contain animal bones.[78] Certainly a few animals could have been kept here by individual owners for private consumption or sale -- some even raised for extended periods of time within the city. The procedure would allow the owner to monitor and control the animal's diet and behaviour, if he desired a certain taste (cf., Varro [*Rust.* 2.4.3] and Pliny [*NH* 8.209] on modifying the flavour of pork), or wished to raise the perfect animal for sacrifice. It is doubtful, however, that this was commonplace. The majority of animals associated with the stalls attached to houses or shops are horses, donkeys, and mules[79]—inedible animals used for work purposes.

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[78] Most of these come from Pompeii. See Richardson et al. (1997).

[79] Richardson et al. (1997) note the recovery of equids found stabled behind the bakery at the House of the Chaste Lovers (IX.12.6-7).

A couple of examples of stalls or folds, presumably for animals, are noted from excavations of market buildings, or *macella*, throughout the Roman world. However, none of these offers proof of any large-scale housing of livestock destined for urban consumption. De Ruyt (1983: 210) describes an enclosure 4.75 m by 93 cm, surrounded by a wall 2.10 m high in the NE corner of the portico in the *macellum* at Pompeii. Complete skeletons of sheep were recovered from this enclosure, and, considering the room led to a religious area, were interpreted as livestock intended for sacrifice and then sale (Frayn 1996: 109).

There is some evidence to support the hypothesis that animals were herded into the city and slaughtered at butchery shops. Animals were certainly brought on the hoof to Rome as part of taxation in kind during Late Antiquity (Sirks 1991; MacKinnon in press, 1996). On a different scale, Livy (44.16.10) suggests that *laniena* can be more specifically used for a slaughterhouse, thus implying that animals walked, or were transported alive, to these shops. Depending on the numbers brought in, and the urban demand, it is possible that some of these animals were temporarily stalled at, or around, the butcher shops. Although possible, this is difficult to prove for Roman Italy.[80] Amongst those urban sites excavated it is hard to locate either slaughterhouses or butchers' shops with open areas beside them which could be used to keep animals awaiting slaughter. Moreover, in the absence of animal bone information from these areas there is no conclusive evidence to indicate that these ever held animals. Some animals could simply have been tethered to posts or walls and not kept in stalls. Regardless of the containment method for animals, certainly shops which sold fresh and/or preserved cuts of meat existed in residential areas of the city. Some are even conjectured as part of the *macellum*, or main market area (e.g., Pompeii VII.9.45 and 46, according to Gassner 1986: 147). However, I predict that the bulk of this meat derived from animals slaughtered somewhere else. Considering the offensive sights, sounds, and smells associated with animal slaughter, it seems practical that much of this which did occur within cities, on any level beyond casual, happened in the more remote districts, and likely in areas downwind from the prevailing winds. Carcasses and/or parts could then be moved to butchery shops for further preparation and sale. Martial's (6.64) comments that "the butcher carried the bloody animal carcass from street to street" insinuates some transfer of raw product. Butchery was not a particularly esteemed occupation, at least according to the ancient texts (Mart. 1.41; Plaut. *Capt.* 4.1.818-200). Thus, I would expect those aspects especially odious, such as slaughter or the initial chopping of the carcass, to be conducted as far away from residential sections as possible—perhaps on the outskirts of the town or beyond its boundaries. A couple of textual references support this hypothesis. The first is an inscription denoting a butcher near the temple of Libitina, probably on the Esquiline hill in Rome, where there was an important market (*CIL* 6.33870; Frayn 1996). The second is a passage in Plautus (*Pseud.* 326-31) which makes reference to slaughtering animals "outside the gate" (of Rome). Meat is more tender if cooked and eaten before the onset of rigor mortis, which usually takes about 12-14 hours after death in the case of cattle (Rixson 1989: 53). This probably allowed enough time to slaughter the animal outside the city, transport the carcass or meat cuts to markets and shop for further butchery and sale, and eventually cook the pieces at the consumer's abode within the same day.

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[80] Late medieval artistic representations of butcher's work-places from Italy show evidence of an enclosure off to the side in which to keep animals (Clark 1992a: 61); however, Ikram (1995: 108) notes that no such enclosures have been discovered from excavations in Egypt.

Most of our available zooarchaeological evidence suggests that some, perhaps many, animals were slaughtered at farms or slaughterhouses outside the city and brought in as either whole or partial carcasses. Several lines of evidence support this proposal. First, the preponderance of butchered bones amongst rural sites suggests that these were the loci of much of this activity. Moreover, the greater incidence of knife lines on bones from rural sites might relate to stripping and packaging of meat for market consumption. Second, in relation to other bones, remains associated with primary and secondary cuts of meat are generally more plentiful amongst urban sites than amongst rural sites. This suggests that slaughter and butchery took place at some rural sites (better examples include San Giovanni) with the transfer of cuts to other areas, most likely urban centres, ensuing. Finally, Martial's (6.64) reference to butchers carrying carcasses from street to street is not specific enough to exclude the possibility that these slaughtered animals were brought from some distance outside the city.

Regardless of the location of the butcher shop or the state in which the animals arrived, most of the meat had to be further cut up by the butcher into the joints and pieces required by customers. As at other types of sites in Italy, animals were probably butchered in towns principally on tables. Suetonius (*Claud.* 15.2) mentions a butcher's table or board where *lanio*, or butchery, could occur. Hooks and racks were also certainly used, but have left little artifactual evidence.[81] That meat not destined to be chopped into pieces may have been sold as whole carcasses. Apicius lists a variety of recipes calling for whole animals of fair size such as boars, lamb, and kid, while Plautus (*Pseud.* 343), Pliny (*NH* 8.78.210), Juvenal (1.140-141), and Petronius (*Sat.* 40, 49) give examples and social explanations for such a display. A whole animal, roasted, could both impress and feed a large group of guests at a dinner party or celebratory feast.

Preservation

Archaeological evidence offers practically nothing to augment textual references about meat preservation. The animal bones themselves provide no direct clues, while structural and artifactual indicators are conjectural.

Drying and smoking help to preserve meat by removing its moisture, thereby limiting the development of micro-organisms which cause decay and putrefaction. Smoking is particularly advantageous in that smoke contains a number of disinfectants which further inhibit the action and proliferation of micro-organisms (van Wijngaarden-Bakker 1984: 195). The ancient sources mention drying and smoking, but they do not give explicit details about the equipment and procedures required. Presumably the meat was laid or hung on a rack and, in the case of smoking, somehow protected to ensure that it was in contact with the smoke but not too close to the heat source to be cooked. In suitable climatic conditions, drying probably took place out of doors where the sun and wind could best rapidly desiccate the meat. Depending on the temperature, humidity, wind velocity, and thickness of meat cut the process probably from took from one to three weeks, during which time the drying area surely had to be guarded or somehow protected from outside pests such as dogs, rodents, or other wild animals. Theoretically, dried meat can last up to two years, but it is not always safe in the later months and is best eaten within a year (Dahl and Hjort 1976: 169).

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[81] There are depictions of rack, hooks, and hanging animal carcasses in Roman art (see Corbier 1989; Toynbee 1973).

There are a few variations of drying meat. Biltong, for example, commonly refers to dried spiced meat. Thin strips are coated in spices such as salt, celery, cumin, coriander, among others, and left to dry. The drying process usually takes between one and two weeks, depending on the weather. Biltong will last around a year, but this period can be extended slightly in drier conditions (Ikram 1995: 150).

Another variant to the drying process is to first boil the meat, before setting it to dry. Although boiling diminishes the chances of subsequent meat decay since it is effective in killing micro-organisms, especially those at the surface, it will also leach the water-soluble protein and liquid fat from the meat, thus reducing its nutritive value. The boil-and-dry process is not referenced in the ancient texts and not commonly practiced in Italy today.

Like drying, smoking meat also requires the right conditions. If meat is to be smoked outdoors the climate cannot be too wet, unstable, or windless to permit drying in the open air (van Wijngaarden-Bakker 1984: 196). Indoor smoking would require a room where an oven or hearth capable of producing much smoke can be constructed. Such a room would also have some ventilation, to allow excess smoke to escape to the atmosphere. In both cases, indoor and outdoor smoking, there must be a sufficient source of available, and ideally cheap fuel.

Smaller, thinner sections of meat stripped from the bone can be dried or smoked much more effectively than larger slabs with bone intact. Thinner pieces, up to c. 5 cm, reduce the chance of trapping moisture and bacteria internally and spoiling the meat (Dahl and Hjort 1976: 169; Pyke 1970: 175). Some groups, such as the Plains Indians, pound the meat thin before drying or smoking it (Weltfish 1965: 212-21). Since thin pieces of meat are ideal, we would expect little zooarchaeological evidence for meat preservation, aside from marked evidence for filleting which is still conjectural since this meat could also have been consumed fresh. Moreover, it is impossible to determine how much meat may have been filleted, given the fact that this procedure might not leave any traces on the bones themselves. A butcher skilled in filleting techniques, a butcher who filleted but left meat on the bones and thus had little chance of contacting the knife with the bone,[82] and the prophylactic effect of the periosteum layer which surrounds a living bone, could all help explain the absence of knife lines on bones. Even in the case of larger sections of meat destined for preservation, most could be easily hung for smoking (drying large pieces is unlikely for reasons explained above) without leaving marks on the bone. The scapula might be pierced (van Mensch and Ijzereef 1977; Schmid 1972), being a relatively thin bone, but it is not imperative, unless a very large weight was to be supported. Meat in this shoulder area might just as easily have been hung by catching the hook through just the muscle mass. Various tendons and other soft tissues throughout the animal carcass can support considerable suspended weight. Moreover, they would be much easier to puncture than bone.

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[82] Peck (1986: 196) notes that the knife is commonly kept at a distance from the bone during filleting in larger butcher shops. Moreover, he reports that "this is more conspicuous in the case of caprine and pig butchery because this meat is not sufficiently prized to justify the investment of energy necessary to fillet bones thoroughly" (Peck 1986: 390).

Although it is likely true that salting was probably the principal method of preserving meat in the past, dating back to at least 1000 BC (Lawrie 1979), and that it had a long tradition during Roman times (van Wijngaarden-Bakker 1984), we have little archaeological evidence to support its existence. The detailed salting procedures given by the ancient authors Cato (*Agr.* 162.1-3) and Columella (12.55.1-4) attest to its importance. While Columella (12.55.1) professes that salted meat should be boned, the use of filleted pieces is implied in the techniques described. One can more easily set, remove, and reset a layer of filleted meat in a jar, tub, or pot than a layer of meat with bone intact. Filleted meat could be packed with fewer spaces between pieces and with a relatively even and secure upper surface, which is especially important if boards were to be placed on top and new layers added. Moreover, joints of meat with bone intact might not fit into preservation jars with narrow mouths, which would otherwise present no problem for filleted and more flexible pieces. Since filleted meat is thus much easier to salt than meat with bone intact, the same complications of recognizing filleted meat in the zooarchaeological record, as explained above in the case of smoked or dried meat would also apply to salted meat.

Salting preserves meat in essentially the same manner as drying and smoking, by desiccating the meat to inhibit the action and development of micro-organisms. The process requires great quantities of salt. Fenton (1973) estimates 30 kg per pig for dry curing and around 1 kg for wet curing (i.e., pickling). While a complete discussion of the salt trade in antiquity is outside the scope of this thesis,[83] the presence of marine resources recovered at inland sites links them to coastal resources, which probably included salt. Oysters shells were especially abundant at Invillino and San Giovanni, both a sizable distance from the coast. Thus, it appears that acquiring salt might not have been a problem for many site occupants.

There is no reason why the Romans should have restricted themselves to one method of preserving meat when several were available and outlined in the texts. In addition, techniques could be, and probably were combined. Cato (*Agr.* 162.2), for example, instructs people first to preserve meat with salt then later smoke it for two days.[84] Each method, however, carries certain restrictions. Smoking is only economical if a sufficient amount of cheap fuel is available. A similar condition can be made for the supply of salt in the case of salt-preserved meat. Drying meat requires no special fuel or resource cost, but it is a less efficient means of preservation compared to smoking or salting.[85] Moreover, unless somehow spiced or flavoured, dried meat is somewhat bland; I suspect most people prefer salted or smoked meat if given a choice.

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[83] Pliny (*NH* 31.39-45) is probably the best ancient source on the subject of salt, while Adshead (1992), Brisay and Evans (1975), and Nequin (1961) discuss aspects of its production, mining, and trading in antiquity.

[84] Although the smoking aspect of this was likely performed to achieve a smoky flavour and assist in drying the meat, rather than as a supplementary preservation technique. Ikram (1995: 159) notes that brining followed by smoking is only done with mammalian meat.

Considering the textual bias in favour of salted meat over other preserved forms, it is possible this technique predominated. A preference for salt-meat is also noted in the historical records for seventeenth century Europe (van Winjgaarden-Bakker 1984: 197-198). There are a number of reasons to choose salting over smoking. First, salting requires less equipment than smoking meat and no specialized facility with proper ventilation. Second, there is no risk of a fire hazard, or smoke inhalation. Third, one can regulate the amount to be salted much more effectively than in the case of smoking where the smoke and fire is less easily controlled. It would be quite wasteful to smoke only a few pieces of meat using a fire that could potentially smoke a much greater amount, especially given the expense of wood. Finally, any meat not sold fresh after a set number of times would need to be preserved. Salting would sufficiently disguise any putrefaction that had occurred, and provide some degree of flexibility, especially to the meat-seller who could not always be sure the weekly or daily quantity of unsold meat which would need to be preserved.

Cooking

Information about cooking meat in Roman Italy is certainly biased in favour of the textual references. The ancient sources detail cooking methods, provide recipes to try for each, and outline seasonal preferences in techniques. They report that meat could be boiled, roasted, fried, grilled, or baked, with boiling and roasting as the more popular choices. The zooarchaeological evidence provides relatively little information for integration, and what is available is often neither specific nor conclusive. Nevertheless, some correlation is noted.

While it is impossible to determine how meat filleted off the bones was cooked, on the basis of zooarchaeological data, the available faunal evidence from Roman Italy suggests that any meat attached to the bones was usually boiled since there are relatively few examples of charred bones. Had roasting been prevalent one might expect to find many more charred bones, especially the ends of long bones which would have been exposed to the coals and flames and subsequently easily burnt. Boiling might have been preferred, as Dosi and Schnell (1986: 76) argue, especially if the occupants favoured soups and broths,[86] and wished to collect the fat which floated to the top of the pot for other recipes or purposes.[87] Boiling also helps tenderize the meat, which would certainly help make the tough meat from older cattle and sheep/goats more palatable. Boiled meat is also easier to preserve than fresh meat, and will keep for a longer period unprotected as well. Apicius' recipes are biased in favour of boiled meat dishes over other cooking methods. The procedure is simple and cost-effective in that little meat (and marrow) would be left on (in) the bones after they had boiled in a pot for some time. The waste bones would then be void of all consumable products, leaving the humans with a hearty stew. Moreover, boiling would ensure the meat was fully cooked, as opposed to grilling which might leave the interior parts half-raw and subsequently forbidden to eat by Christian standards at least (Arn. *Adv. nat.* 2.68; Corbier 1989: 235). To achieve thorough cooking, meat was often boiled before being roasted (André 1981: 146, 220; Corbier 1989: 235).

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[85] Salt draws out the liquid in the meat, thus causing it to dry more evenly and efficiently. Smoking kills more microbes than drying and simultaneously reduces the amount of water present in the meat. (Pyke 1970: 174).

[86] Corbier (1989: 235) suggests that obtaining broth was a primary concern in Roman cooking, considering the mediocre cuts of meat often used, and the predominance of boiling references in the texts.

[87] Harris (1985: 41) notes that "much of the nearly worldwide hunger for meat is really a craving for fatty meat," the Roman people were not uncommon in this respect. A number of ancient references specifically mention fat animals, especially pigs (e.g., Col. 7.11.1; Varro *Rust.* 2.4.4, 2.4.12; Juv. 13.117-118; Prop. 4.1a.21-24; Macr. *Sat.* 5.11.23; Cels. 2.18.10; *Ed. Diocl.* 4.10), while lard and grease, both at 12 *denarii*/lb. (Ed. Diocl. 4.10), were more expensive than comparable weights of most meats. Moreover, fattened hens, pheasants, and geese sold for twice the price of their unfattened equivalents (*Ed. Diocl.* 4.17-23). Corbier

The predominance of boiling meat over roasting is further suggested at some sites (e.g., San Giovanni) by the relatively haphazard approach taken by the butcher in chopping and cutting up the carcass. "Simply to remove the meat from the carcass and reduce it to pot-sized pieces could have given rise to a chop-and-slash approach" (Rixson 1989: 56). As noted earlier, the butchery of cattle and sheep/goat skeletons at San Giovanni is less standardized than that for pigs, with more examples of a "chop-and-slash approach." It is possible that relatively more beef and mutton was boiled than pork. This is not unlikely given the Roman preference for pork over other meats. Presumably the occupants at San Giovanni wished to vary the methods used to cook pork, while resorting to boiling for less-favoured meats.

While roasting and grilling meat are documented in the texts, these cooking techniques have left few traces in the zooarchaeological record. There are several ways to grill and roast an animal and its meat, and not all of these methods will result in charred bones. Obviously, deboned grilled or roasted meat will not show in the osteological record, and even if it could be determined that meat was filleted off the bone by examining butchery marks there is no way of telling how this may have been cooked without other sources of evidence. Alternatively, whole animals or sections of meat with bone intact can be roasted. Dosi and Schnell (1986: 77) note that grilling and roasting whole animals on the spit was not too common in everyday Roman cooking, but was the typical method used for cooking sacrificial animals or those prepared for feast occasions where a number of people would be taking part. The display would certainly be impressive and with the large crowds there would be less chance of meat being wasted.

Marrow extraction is not specifically mentioned in the ancient texts, but it certainly occurred. Zooarchaeological evidence indicates fracturing of animal long bones, especially the humerus, femur, radius, and tibia of medium-sized and large domesticates. Cattle metapodials were similarly treated. Such intentional fracturing is usually associated with marrow extraction. It is difficult, however, to judge how widespread marrow extraction was in Roman Italy on the basis of available evidence, especially since many agents can fracture bones. On the basis of the relatively small number of complete long-bones recovered (see Tables 26, 38, and 46), I would suggest that marrow was of some value to the ancient Romans, but had it been of principal importance I would have expected fewer

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(1989: 236-237) comments further about the ancient Roman's fascination with fat and dietary preference for fatty animals.

cattle metapodials to survive in a complete state. Cattle metapodials are ideal for marrow extraction. They are immediately available after slaughter, and unlike more meat-rich long-bones with large medullary cavities such as the femur and humerus, the metapodials do not have to be filleted beforehand, since they are surrounded by little and poor-quality meat (Peck 1986: 66). Thus, the impression for marrow exploitation in Roman Italy is the same as that concluded by Peck (1986: 66) for sites in Roman Britain, specifically that "marrow extraction was not a stock policy applied systematically to every anatomical element which possessed a larger medullary cavity."

Although the texts suggest that meat cooking techniques varied according to the seasons—with boiling, prevalent in the winter, gradually giving way to roasting in the summer (Cels. 1.3.34-35)—this is difficult to examine in the zooarchaeological data. There are no strictly seasonal sites amongst those used in this thesis; all of them were occupied year-round, even though the population at some of them may have varied seasonally. In the absence of age information for the animals contributing the burnt bone pieces, it is impossible to determine during what season this charring may have occurred. Even if this was possible, it still hinges on an assumption that mating and birthing followed a seasonal schedule. Moreover, as noted above, we cannot always be sure if charring on a bone is the result of a cultural activity, such as cooking, or is due to some other event such as an accidental fire. More information about the position and intensity of the charred marks is required to help clarify these issues.

Part 2: MEAT IN THE ROMAN DIET

Presentation of the zooarchaeological data in this section is divided into two sections: meat weight analysis and body parts analysis. The former provides an idea of the relative amount of meat each animal taxon contributes on the basis of NISP or MNI statistics, while the latter examines the frequency of cuts of meat from the various parts of the skeleton. The two are related in that meat weight studies tell us which animals were eaten and in what relative proportions, while a body parts study provides information about which meat cuts from those animals were consumed.

Zooarchaeological Evidence

Meat Weight Analysis

While NISP and MNI values give an idea of the relative abundance of animal taxa, modifications must be made to get a sense of the amount of meat made available. Estimates of the meat weight provide some idea of the minimal amount of meat represented by a sample of bones, and thus aid in the reconstruction of ancient diets. Although there are several methods used to estimate meat yields,[88] in the absence of detailed data on the ages, sizes, and elemental composition of individual animals at each site, I found I could only effectively apply a couple of methods. The first of these expresses the amount of meat one animal gives in relation to another (e.g., 1 cow = 5 pigs = 8.4 sheep/goats) then adjusts the NISP figures accordingly. This method relies on meat weight "constants" to arrive at the original ratio (e.g., 225 kg for cow, 45 kg for pig, and 26.8 kg for sheep/goat, converts to the ratio given above).[89] In the second method MNI counts for individual taxa are multiplied by corresponding meat weight "constants" to get an idea of the minimum amount of meat.[90]

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[88] See Lyman (1979), Reitz et al. (1987), and Vigne (1991) for further discussion.

While both methods are relatively simple, they are nonetheless contingent on the values being used for the meat weight "constants." Comparisons become problematic when we consider that these meat weight "constants" were not always consistent amongst these Roman period sites in Italy. I counted seven different values used in the calculation of cattle meat weights from the reports which performed this exercise (170, 192.5, 200, 225, 226, 227, 275 kg), five different figures for sheep/goat (25, 27, 27.5, 28, 30 kg), seven distinct values for pigs (45, 46, 49.5, 60, 63, 70, 80 kg); two for horses (100, 200 kg), three for red deer (90, 100, 150 kg), and only single values for several other common wild animals (wild boar: 70 kg, roe deer: 30 kg, hare: 5 kg, rabbit: 2 kg).[91] There is often minimal to no justification as to why particular figures were chosen for each report, which makes it difficult to compare samples. Moreover, there is no correlation between certain figures and certain geographic areas or temporal phases. For example, cattle "constants" range from 192.5 to 226 kg amongst sites in central Italy, and from 175 to 227 kg in northern Italy. Similar broad ranges occur within the three time periods (Republican, Imperial, Late Antiquity). To further complicate the matter, differences in breed sizes are usually not considered in the calculations, even if such variation is known to exist. It is true that the potential meat weights and multiplication factors used in these calculations, and in turn all meat weight estimates, are to be viewed as relative rather than absolute figures. However, I urge that more attention be paid to choosing figures appropriately on the basis of size, breed, and other morphological and metric data, to facilitate future comparative research.

Meat weight is certainly contingent on size; therefore, in order to calculate better these values, some idea of size variation is required. According to the withers height estimates for cattle, sheep/goat, and pigs as recorded in Tables 26, 38, and 46, respectively, the range between the largest and smallest animal is:

- **cattle: 49.3 cm** (i.e., 150.1 cm - 100.8 cm = 49.3 cm)
- **sheep/goat: 25.8 cm** (i.e., 79.4 cm - 53.6 cm = 25.8 cm; note - although the maximum value from Table 38 is 88.9 cm, it is exceptionally high and so I chose the second highest value for this calculation)
- **pig: 28.2 cm** (i.e., 85.5 cm - 57.3 = 28.2 cm)

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[89] Bökönyi (1984) was one of the first zooarchaeologists to use this method. The ratios obviously vary depending on the meat weight constants being used. Bökönyi (1984: 102-103) states 1 cow = 7 sheep/goat, and 1 pig = 1.5 sheep/goat. Cartlege, Clark, and Higgins (1992: 318) use the equation: 1 cow/ox = 5.0 pigs = 8.4 sheep/goat.

[90] White (1953) first proposed this technique. Lyman (1979) provides further discussion.

[91] Appendix 12 lists these figures by site.

In the absence of specific data about the size and weight relationship for ancient animal breeds in Italy I estimated, on the basis of Vigne's (1991) research on animals in Corsica, and Noddle's (1973) figures for cattle, that each centimetre increase in withers height corresponded to a 1 kg increase in meat weight for both sheep/goat and pigs, and a 2 kg increase in cattle.[92] I established base figures of 150 kg, 15 kg, and 35 kg for the meat weight of cattle, sheep/goat, and pig respectively. I chose a relatively low weight for pigs to conform with the small size of Roman pigs compared to modern heavy breeds (Clutton-Brock 1981). To these I added the appropriate withers height range as converted into meat weights. This left an upper limit of 248.6 kg for cattle (i.e., 150 kg + 49.3 kg x 2), 40.8 kg for sheep/goat (i.e., 15 kg + 25.8 kg) and 63.6 kg for pig (i.e., 35 kg + 28.2 kg). Then I converted each mean value in Tables 26, 38, and 46 to its corresponding mean meat weight, or individual "constants" for each region/time period group. These are listed in Table 52.

I begin my analysis of meat weights with a review of the relative contribution of meat from domestic mammals compared to wild mammals, after which I will examine the principal domestic taxa—cattle, sheep/goat, and pig—in detail.

Domestic vs. Wild Meat

Appendix 13 lists the frequency of domestic and wild meat as estimated using MNI values and the appropriate meat weight "constants" from Table 52. Domestic values comprise totals from the three primary taxa: cattle, sheep/goat, and pig. For wild mammalian species, the following meat weight "constants" were used: red deer—80 kg, roe deer—18 kg, fallow deer—40 kg, wild boar—65 kg, hare—4 kg, rabbit—1 kg, dormouse—0.1 kg. These are based on average live weights as reported in Naether (1967), Whitehead (1972&1993), and Burton (1991). I assume that all other wild taxa (e.g., foxes, wolves, badgers, and so forth) were not consumed, since there is no mention of this is in the ancient texts or any historical documentation from subsequent cultural periods, and therefore they have been excluded from this analysis of meat weights.[93]

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[92] Vigne's (1991) graphs of the relationship between withers height and live weight for cattle, sheep, and pigs show a 1 kg increase in meat weight for every centimetre increase in the height of sheep, but a corresponding c. 2 kg increase for pigs and c. 6 kg increase for cattle. His live weight and meat weight estimates for cattle seem relatively high in relation to those given by Noddle (1973). The mean between the maximum and minimum fat-free carcass weights for group A cattle in her table (Noddle 1973: 382) is 194 kg. The differences between the maximum (i.e., 225 kg.) and minimum (i.e., 133 kg) meat weight values in Noddle's example is 122 kg. Applying a similar range to the Roman cattle in Italy converts to c. 2-2.5 kg increase in meat weight/cm increase in withers height. I have chosen to use the lower value of 2 kg to compensate for the presence of smaller cattle breeds in Roman Italy compared to modern England. Vigne's (1991) live and meat weight estimates for pigs are also relatively high, and probably relate to earlier wild boar/domestic pig hybrids (e.g., the Neolithic examples have a reported withers height of 73 cm and a meat weight of c. 112 kg. [Vigne 1991: 31]), and modern larger pigs (e.g., reported withers heights for these are 50-60 cm with corresponding meat weight estimates of c. 65-80 kg. [Vigne 1991: 31] than to comparably smaller Roman domestic pigs (which I judge to average about 50 cm at the withers). To compensate for the smaller size, the meat weight estimate for pigs has been lowered from Vigne's (1991) c. 2 kg increase/cm increase in withers height to 1 kg increase in meat weight/cm increase in withers height.

[93] Although Petronius (*Sat.* 66) mentions eating bear, it is the only reference to this activity. From the context it appears to be an uncommon event; therefore, I have not included bears in the meat weight analysis.

It is apparent from the data in Appendix 13 that wild meat was only a minor component in the Roman diet in Italy. Wild animals contribute less than 10% of the total meat available at over three quarters (76%) of the sites listed, as calculated on the basis of MNI figures. Nearly one-third (29%) of all these sites recorded no wild mammals at all which might be consumed.

Table 53 summarizes the data in Appendix 13 by grouping sites according to shared geographic region, time period, and site type criteria. Only sites with total MNI counts of ten or more have been included in this analysis.

There are always problems in interpreting meat weight results.[94] One problem is that, as noted above, individual animals within a species potentially contribute varying amounts of meat, depending on genetic and environmental factors such as age, sex, size, and nutrition. I have tried to compensate for the temporal and geographic variation in cattle, sheep/goat, and pig size by utilizing different meat weight "constants" as calculated in Table 52; however, in the absence of complete data on the age, sex, and nutritional status of the animals that comprise these faunal samples, coupled with insufficient information about the average amount of meat an animal from each of these individual age/sex/nutritional state classes might contribute, it is impossible to the achieve anything but a meat weight "estimate."

A second criticism of calculating meat weight estimates on the basis of multiplicative methods using MNI values and meat weight "constants," is that these methods assume whole animals were consumed. This was certainly not the case at all sites in antiquity, in terms of domestic animals (as is discussed later in this chapter), or wild animals. Wild animals, and especially the larger ones, are often represented at Roman sites by only a few elements like antler fragments or metapodials and phalanges. More rarely are enough remains from all parts of the wild animal's body recovered to indicate disposal of a whole carcass. The possibility exists, therefore, of exaggerating the amount of meat both domestic and wild animals contribute to the diet. However, this bias need not necessarily inhibit the use of meat weight estimates to examine patterns in the data. We simply must be aware that what these values really estimate is the amount of meat potentially available from the minimum number of animals represented in the faunal sample. That portion of this which is consumed is certainly contingent on these larger amounts. Thus, by examining the estimates of the amount of meat available some idea of the potential contribution of this to the diet can be formulated.

Recognizing the biases and limitations of using meat weight estimates, I offer several points about the data in Table 53. First, the average values for wild meat never reach beyond 12% of the total meat, suggesting that wild meat never contributed a significant portion of that meat consumed regardless of site type. However, the values do vary, and the data support the hypothesis that wild meat formed a greater part of the Roman rural diet as opposed to that in any urban context ($X^2=5.11$, df=2, $0.1<p<0.05$), although owing to the biases outlined above it is difficult to determine to what degree they differed. Second, the data suggest that wild meat was consumed relatively more often in Republican times than during other periods. Ignoring the special sites, the data show a steady decline over time in the mean frequency of wild meat at rural sites in both southern and central Italy, and urban2 sites in the north. Third, urban1 sites display a drop in the mean frequency of wild animals from Republican to Imperial times, but this is followed by an increase into Late Antiquity. A rise in mean frequency of wild animals between earlier and later time periods is also noted at urban1 sites in southern Italy, but this pattern is based on data from single sites only. Finally, domestic species clearly predominate at special sites, regardless of context, but some wild mammals also contribute to the meat supply at these sites, again most notably during Republican times.

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[94] Grayson (1973, 1979, 1984) provides further discussion.

Lyman (1979) suggests using butchered units of meat instead of whole animals in meat weight estimate calculations. In his method, the MNI values for various skeletal elements associated with butchered cuts of meat are multiplied by the weight of meat associated with that particular cut. For example, an MNI of "4" for the category of pig's feet multiplied by the meat weight of 0.27 kg/pig foot yields a total meat weight of 1.1 kg for this particular butchery unit, i.e., the pig's foot (Lyman 1979: 543). While this method overcomes problems of meat over-representation (as outlined above) it could not be applied in my analysis here for two reasons. First, it is contingent on MNI calculations for individual skeletal elements, and ideally for both left and right sides. While fifty-nine sites (or parts thereof) reported element-wise NISP counts, only nine of these (Vaste [Hellenistic], San Giovanni [Period 2 and 3], Narce, Populonia, Lugnano [Period 2 and 3 villa; cemetery], Modena) had also listed these according to MNI counts and even then this was not always consistently performed for all animal taxa.[95]

A second reason why Lyman's (1979) butchery unit method for estimating meat weights could not be employed here is that there are no butchery unit meat weights presently available that are specific for ancient Roman animals in Italy. Lyman (1979) uses estimates for his butchery units (e.g., hindshank, loin, flank, jowl, etc.) which are based on early twentieth century domestic breeds of cattle, sheep, and pigs in northwestern United States (Boyce 1937; Eakins 1924). The average pig and cow from this region and time period was much larger than its taxonomical equivalent from Roman Italy.[96]

Another method used to predict meat weights from zooarchaeological data relies on the use of allometric equations. These relate "proportional changes between parts of an organism as the size of the animal increases" (Reitz et al. 1987: 305). Much of the allometric research in zooarchaeology has focused on the relationship between bone weight and edible meat weight, and has been principally conducted using fish remains (Jackson 1989; Reitz et al. 1987). Such methods could not be applied in my analysis since bone weight was very rarely recorded among sites. Some zooarchaeologists have examined the relationship between body weight and bone measurements such as the lateral astragalus length (GLl) or the depth of the femur head (DC), but the results have been widely divergent depending on the skeletal element (Reitz and Honerkamp 1983; Reitz et al. 1987), and the topic is in need of further research before it can be implemented reliably.

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[95] Vaste reports element-wise MNI counts for pigs only, and Populonia those for cattle exclusively. The other sites generally only calculate these values for consumed domesticates and not wild animals.

[96] Lyman (1979: 540), after Boyce (1937) and Eakins (1934), provides a carcass weight range of c. 250-381 kg for cattle, and c. 84-89 kg for pigs. Compare this with meat weight "constant" ranges (see Table 49) which have been applied to Roman period sites in Italy: 170-275 kg for cattle and 45-80 kg for pigs.

Domestic Mammals

As shown in Table 53, domestic mammals—cattle, caprines, and pigs—contribute the bulk of the meat for the Roman diet regardless of site type, geographic locale, or time period. Appendix 14 lists the relative frequency of cattle, sheep/goat, and pig meat calculated on the basis of NISP frequencies, and using the appropriate meat weight constants from Table 52.

The data in Appendix 14 reveal an extreme range of meat weights. Rural sites show the greatest variation. The amount of meat pigs provide to rural diets spans from about 10% to over 90%, while that of cattle also account for over an 80% difference between maximum and minimum frequencies. Urban1 and urban2 sites exhibit less overall variation than their rural counterpart, but the differences are still substantial, with each animal running close to, if not quite over, a spread of 40 percentage points between highest and lowest values. Special sites are unique, with some animals not registering at all in the meat weight tally.

Figure 23 summarizes a portion of the data in Appendix 14 by presenting the mean meat weight frequencies of cattle, sheep/goat, and pig according to geographic region, temporal period, and site type, for rural, urban1, and urban2 sites. Sample sizes are noted next to the region/period/site type markers. Table 54 lists the mean meat weight frequencies for cattle, sheep/goat, and pigs for special sites, while Table 55 provides the average values of these for each of the four site-type categories. The number of sites comprising each group is noted in parentheses. Only sites with cattle+sheep/goat+pig NISP totals of at least 100 are included in Figure 23, and Tables 54 and 55.

The mean meat weight values presented in Figure 23, and Tables 54 and 55 highlight the great variation in dietary patterns amongst site types and within the various geographic and temporal groupings. Although the number of sites comprising each category is often only one or two, some comments about general trends in the data can still be made.

While cattle NISP figures may have been dwarfed by those of sheep/goat and pigs in Table 16 and Figure 7, a different picture develops when these values are converted into meat weights. Ignoring the special sites, in all but one instance (S/1/r) cattle account for more than one third of the total domestic mammalian meat consumed as shown in Figure 23. Cattle register their lowest average values in central Italy, and their highest amongst urban sites in southern and northern Italy, where they consistently account for more than half of the total meat weight. Beef progressively and dramatically declines in importance over time at rural sites in southern Italy, but remains popular at settlement and urban areas over this same period. Cattle at urban1 and to some extent rural sites in central Italy are consumed less often relative to other domesticates in the period from Republican times to Late Antiquity, with urban 1 sites registering slightly smaller values than their rural counterparts. Beef forms a significant amount of the meat consumed at sites in northern Italy at all times. The data show that it is favoured less at rural sites than either urban1 or urban2 sites. Moreover, the latter two show a marked increase in the contribution of beef and veal to the diet moving from Republican to Imperial times.

The amount of meat that sheep and goats contributed to the diet, as shown in Figure 23, is much less than that of cattle. In nearly every case, mutton and lamb register less than 25% of the domestic mammalian meat consumed. Sheep/goat meat is most consistently abundant at rural sites in Republican and Imperial southern Italy; however, its contribution drops drastically into Late Antiquity in this area, at both rural and urban1 sites. Lamb and mutton account for around one-fifth of the total domestic mammalian meat at both rural and urban sites in central Italy during the Republican period. This declines into Imperial times—sharply at rural sites, less so at urban1 sites—but finds some resurgence in popularity during Late Antiquity. Northern Italy displays a reverse pattern to that of central Italy. The data indicate that, on average, mutton and lamb contribute very little meat to the Republican and Late Antique diet in this area. During Imperial times, however, they are quite important, registering values double, even triple those of other periods in the area, at least amongst urban sites.

The data from Figure 23 highlight the general popularity of pork in the Roman diet. This is especially recognized at Imperial and Late Antique rural and urban1 sites in central and southern Italy, where pork registers close to, if not more than, half of the mammalian meat consumed. Both rural and urban1 sites in southern Italy progressively increase their production and consumption of pigs from Republican times through Late Antiquity, although the change is much more dramatic at rural sites. A similar significant rise is also seen between Republican and Imperial times for rural and urban1 sites in central Italy, but this is followed, in both cases, by a slight decline in pig values for Late Antiquity. The pattern of pig meat consumption in northern Italy is similar to that shown for central Italy. Here, urban1 sites show a slight increase in the relative contribution of pork to the diet from Republican to Imperial times. These frequencies hover near 40%. The trend of increased pork consumption over time is also shown at urban2 sites in northern Italy, but on average these figures are less than half those shown for urban1 sites in the both central and northern Italy. Finally, pork comprises about a third of the domestic meat diet at northern Italian rural sites.

Appendix 15 lists the relative frequency of cattle, sheep/goat, and pig meat calculated on the basis of MNI frequencies, and using the appropriate meat weight constants from Table 52. Figure 24 summarizes the data in Appendix 15 by presenting the mean meat weight frequencies of cattle, sheep/goat,-and pig according to geographic region and temporal period for rural and urban site types. Table 56 lists this information for special sites, while Table 57 provides the average cattle, sheep/goat, and pig meat weight values for each of the four site type categories. The number of sites comprising each group is noted in parentheses. Only sites with cattle+sheep/goat+pig MNI totals of at least ten are included in Figure 24, and Tables 56 and 57.

Although there are some discrepancies in the magnitude of the values and in the patterning produced by the meat weight estimates derived from MNI as opposed to NISP figures, overall the two show many similarities, despite the small sample sizes notably in the MNI charts. The patterning of increase and decrease over time for each geographic cluster of rural, urban1, and urban2 sites correlates in all but a few cases. This is especially evident in the comparison of NISP and MNI meat weight estimates for rural sites. Both show a progressive increase in pork consumption in southern Italy from Republican times to Late Antiquity, with a concomitant decline of beef in the diet. Sheep/goat meat is popular at earlier periods in southern Italy, but dwindles in importance over time, especially at rural sites. Overall, the meat weight estimates for most site types as derived from MNI statistics concur with those derived from NISP statistics in terms of the unimportance of sheep and goat meat to the general Roman diet. Almost all of these frequencies are less than 20%, regardless of quantifier. Cattle register high meat weight frequencies, especially amongst sites in northern Italy. Although the MNI derived figures here vary in relation to their NISP counterparts, the standard of increased beef consumption from Imperial times to Late Antiquity holds true, at least at urban1 sites. Cattle also register fairly high MNI values in central Italy, with some temporal fluctuation, when compared against their NISP equivalents. However, there is a notable drop in beef consumption amongst rural sites moving from Republican to Imperial times, which is not shown at urban1 sites over the same period. This drop coincides with an increase in pork consumption over the same period, and again is clearly shown in both NISP and MNI tallies at rural sites in central Italy.

Body Parts Analysis

When animals are butchered, the carcass is reduced into smaller joints or cuts of meat. Some of these are associated with good quality meat, destined for consumption, while others yield poor, or no meat, and are often discarded as waste. Generally, the most tender and tastiest meat derives from around the central area of an animal (i.e., shoulders, back, pelvis) and extends to the upper part of the legs (i.e., humerus, femur bones). These areas are commonly considered "primary cuts."[97] As one moves away from this central core, both the quality and quantity of meat is reduced. "Secondary cuts" comprise the middle part of an animal's leg (i.e., radius, ulna, tibia, and fibula), while "extremities" include all elements of the toe or paw (i.e., metapodials, carpals, tarsals, phalanges). Extremities are often discarded as waste, since they contain little meat relative to other body parts, and what is available is often quite tough. The head of the animal too is usually considered a waste product; however, it does contain the brain, tongue, eyes, and jowl muscles which can be consumed, although these are not universally palatable.

I stress that the classification scheme using "primary cuts," "secondary cuts," "head," and "extremity" is oriented around the relative amount and quality of the meat associated with each category. There are certainly other products which can be exploited, some of which may be specific to a certain category. Horns, for example, are a component of the "head" category. Cattle metapodial bones, part of the "extremity" category, although generally considered as butchery waste in terms of meat exploitation, can be broken, along with other long bones, for the marrow they contain. In addition, cattle metapodial bones are the principal raw material chosen for Roman bone-working handicraft (MacGregor 1985; Hutchinson and Reese 1988). Sheep/goat and pig extremity bones, however, are much smaller than those of cattle and less likely to be specifically exploited for marrow, or used as raw materials in bone working. Nevertheless, these supplementary uses must be considered in any analysis of animal body part representation, especially in the case of cattle.

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[97] The name designations (i.e., "primary," "secondary," "head," "extremity") and associated bones of these four "meat cut" categories are relatively standard in zooarchaeology; mine follow Barker (1982).

By comparing the frequency of bones associated with each of these cuts, in light of taphonomic biases, one can get an idea of the relative completeness of the carcasses represented. A marked preponderance of extremity bones for example (factoring in differential preservation) indicates that whole carcasses were not present. Such a pattern suggests that the better quality cuts of meat (and the bones associated with them) had been removed and deposited elsewhere, leaving behind the extremities as waste. Conversely, a predominance of primary cuts might suggest that these occupants consumed good-quality meat, which may have been purchased as a butchered joint as opposed to acquiring a whole animal and butchering it on the premises. While any mammalian taxon may be examined in terms of the representation of skeletal parts noted from the zooarchaeological remains, I limit my analysis of this topic here to cattle, sheep/goat, and pigs, because, as indicated earlier, these domesticates provided the greatest amount of meat to the Roman diet. In addition, information and tallies about their skeletal parts are commonly included in faunal reports, while this is not always available in the case of other mammalian taxa.

Cattle Parts

Appendix 16 lists the total NISP and associated frequency of the four categories of meat cuts for cattle. Although ribs and vertebrae can be considered amongst "primary cuts" since they derive from the chest and back area of an animals, I have not included them in the tallies here. Not all of the reports provided NISP figures for these elements; therefore including them would considerably bias recordings. Furthermore, given the difficulty in identifying rib and vertebrae to species, I could not be assured of the degree to which individual researchers attempted such a task (i.e., only whole pieces?, just part of the sample?) or if similar techniques were used.

Table 58 summarizes the information from Appendix 16 by listing the range and mean frequency for each of the four skeletal parts categories according to site type. Only sites with cattle NISP sample sizes greater than 40 have been used in these calculations. The number of sites comprising each site type is given in parentheses.

The great span in range values for all skeletal part categories, regardless of site type, is clear. Even the smallest spread (i.e., primary cuts at special sites) is still a ten percent jump, while some of the larger ranges encompass a zone over fifty percentage points. Such extensive ranges highlight the great degree of variation in bone samples, even between sites which may otherwise seem quite similar.

Recognizing that considerable variation exists, I offer some general comments about the patterning amongst mean values presented in Table 58. By relying on these mean values I am restricted to documenting the average, or typical, site (rural, urban1, urban2, special), and there will no doubt be individual sites which diverge widely from their respective mean patterns. I shall examine such atypical sites on an individual basis later in this thesis.

A comparison of the mean values in Table 58 reveals a fairly consistent pattern. The head category generally dominates (with values between 30 and 40%), followed closely by extremities (around 26-35%). Primary cuts register tightly around 20%, while secondary cuts lag around 9-15%. The only exception to this pattern is urban1 sites. Here the order of the top two categories reverses. Extremities predominate (32.5%), followed by heads (30.4%) then primary and secondary cuts as shown elsewhere. Overall, however, the data show that there is little variation among the site types in terms of the average representation of cattle parts identified. Aside from the excess of extremity parts and concomitant slight under-representation of head elements at urban1 sites, as compared to other site types, the only noteworthy trend is a quite high head mean value at urban2 sites (35.7%) with a simultaneously low secondary cut value (8.8%) in relation to other sites (13.0-14.6%). This suggests that relatively more heads are represented at urban2 sites, with some export, or at least disposal elsewhere, of secondary cuts.

If judging these mean frequencies at face value, and giving equal weight to each elemental category, one might be tempted to conclude that cattle heads and extremities are typically over-represented (since they generally figure more than 25%, respectively), while primary and secondary cuts are under-represented (i.e., record less than 25%). However, it must be remembered that these values alone do not tell us if whole or part animals are represented. Two biases must be addressed. First, head and extremity values are predisposed to be larger since both categories contain a greater number of potential bones to count compared to primary or secondary cuts. For example, one might count the horn, cranium, maxilla, mandible, and separate teeth (i.e., incisors, premolars, molars) amongst the head values, accumulating a total from more than five individual bone counts, while the secondary cuts category contains a total from only three bones (radius, ulna, tibia). Thus, one must standardize for the numeric variation between skeletal elements constituting each category.

Taphonomic factors bring another bias. Bones are differentially destroyed. Carnivores tend to gnaw certain bones, or part of bones, first (Payne and Munson 1985). The humerus and cranium are good examples. Other bones, especially the distal tibia and phalanges, often escape destructive gnawing. Moreover, carnivores are not the only agents. A number of taphonomic factors act on a bone sample, with differential results. Because of their resistant nature, teeth survive well, while other bones might be destroyed more rapidly (e.g., weathered, gnawed, and so forth). Determining the incidence and prevalence of taphonomic destruction, therefore, is crucial to understanding the culture associated with a bone sample.

To understand this problem better, I attempted to standardize these mean values. I divided the means for primary and secondary cuts by the number of bones which constitute those categories: "4" for primary cuts (i.e., scapula, humerus, pelvis, femur), and "3" for secondary cuts (i.e., radius, ulna, tibia). I reviewed survivorship rates of these bones as determined from experimental research (Brain 1981; Payne and Munson 1985; Lyman 1984, 1994a) and concluded that these were fairly equal for each category. Both had elements which survive well (e.g., scapula neck, distal tibia) as well as elements which are readily destroyed (e.g., humerus, distal ulna). I divided the head category by a factor of "9". This corresponded to the horn core, cranium (all but maxilla, and combined as one), maxilla, mandible, mandibular incisors (combined as one), and upper and lower premolars and molars (a count of four). Owing to pronounced taphonomic destruction of cranial pieces, I combined all separate bones of the cranium into one category. Furthermore, I attempted to compensate for missed teeth (recovery bias) by grouping premolars and molars into maxillary and mandibular categories. Finally, I divided the extremity value by a factor of "6," which I arrived at by tallying metacarpal, metatarsal, phalanges 1, 2, and 3, and a combined astragalus/calcaneum/carpal/tarsal category. Phalanges were counted separately since they tend to preserve well, despite their small size; however, I grouped all carpals and tarsals together since they survive less well and are often missed without the use of screens.

I stress that my standardization factors of 9, 4, 3, and 6, for head, primary, secondary, and extremity categories, respectively, are essentially a guide with which to interpret better the **overall, average** data on skeletal parts. There will certainly be sites which require modifications in these values, due to specific taphonomic and/or recovery biases, if they are to be examined on an individual basis.

Table 59 lists the mean values for cattle parts from Table 58 as divided by the standardization factors outlined above. The statistics in Table 59 provide a clearer method with which to recognize deviations in part representation. Fairly equal statistics among the various parts categories at a single site type suggest that whole animals are represented, while pronounced discrepancies suggest differential distribution (i.e., export of some cuts, disposal of some parts elsewhere, etc.). Relatively complete cattle appear to be the norm at rural and special sites, especially when one compares the values for primary, secondary, and extremity parts, all of which hover close to 5.0. The statistic for heads at rural sites is somewhat low (3.8 compared to around 5.0 for other parts), suggesting some differential disposal of heads. In addition, the value for extremities is a bit high, which supports the notion that some cattle parts were exported with more lower leg waste products kept on site. Neither heads nor extremity values, however, differ sufficiently from the others to contradict the suggestion that the majority of cattle killed and consumed at most rural sites were whole animals. Similarly, it appears that whole cattle (or at least all parts of cattle) are disposed of at special sites. Whole cattle likely constitute a proportion of the animals from urban sites too, judging by the closeness of statistics for urban1 and urban2 sites, but the data suggest some differential disposal as well. Heads are comparably under-represented at urban1 sites, while extremity parts are quite prevalent. It appears that relatively more feet and toe bones of cattle have been found at urban1 sites, while fewer heads make it to this destination. Urban2 sites, on the other hand, contain overall fairly complete cattle, but the low value of secondary cuts (2.9) lends support to the hypotheses that these cuts were: (i) exported out of the urban area, (ii) not imported to the same degree as other cattle parts, or (iii) disposed of elsewhere.

Table 60 lists the standardized statistics for cattle part mean frequencies on the basis of geographic area and site type. Only sites with cattle NISP figures of more than 40 have been used. Sample sizes are given in parentheses. Although sample sizes are small, the data from Table 60 show several patterns. Southern Italy claims the highest average statistics for extremity parts and the lowest for head and primary parts of all three areas. Moreover, its values span a substantial range: 2.9 to 7.7. This suggests that fewer whole cattle were deposited amongst sites in southern Italy, compared to other regions. Instead, it is the waste products of the lower legs which predominate. This pattern is particularly evident amongst the rural sites from southern Italy. In contrast, average values for northern and central Italy indicate deposition of relatively more complete cattle in these areas. A closer examination of the statistics, however, reveals that while rural sites in central Italy generally contain the remains of whole cattle (unlike the case for southern Italy), the samples are skewed in favour of primary cuts and extremity parts at urban sites and heads at special sites. The inflated values for cattle primary cuts at urban1 sites in central Italy may relate to import of better-quality beef cuts, while the predominance of extremity bones may relate to hide processing or bone-working activities in cities. The foot bones, which are often still in a hide, are later discarded as the leather is processed. On the other hand, lower leg bones, especially the metapodials of cattle, are coveted as valuable bone working material. Finally, an interesting connection develops between urban and rural sites in northern Italy. Rural sites display a preponderance of head and secondary cuts but few primary cuts and extremities, while urban sites show the reverse pattern. This suggests that lower-grade cuts of meat were kept for consumption at rural sites in northern Italy. The associated bones were disposed of on site along with skeletal waste from the cattle's head, while better-grade cuts of meat and extremities were transported to urban areas, either for consumption (e.g., primary cuts) or as part of hide processing or worked-bone manufacturing (e.g., extremities).

Lastly, Table 61 lists the standardized statistics for cattle parts as grouped by chronological period. Only sites with cattle NISP figures greater than 40 have been included. While there are difficulties in pooling sites of different type and in different geographic areas by a shared time period, the data from Table 61 indicate a general increase in the relative frequency of head and secondary cuts over time, with a corresponding drop in the frequency of extremity parts. Primary cuts fluctuated over time, declining from Period 1 to Period 2, before augmenting in Period 3. The range amongst the Period 2 and Period 3 statistics is much reduced compared to that for Period 1, suggesting that relatively more complete cattle were deposited in the latter two periods. The low value for heads among Period 1 sites may relate to differential deposition during this time, with heads disposed elsewhere, away from the rest of the carcass (and fewer of these types of deposits excavated). In addition, the high value of extremity parts for Period 1 suggests that relatively more of the Period 1 deposits excavated contained butchery and processing waste, rather than the better cuts of beef presented for consumption. This may relate to variation in butchery techniques. Perhaps butchery was more compartmentalized during Republican times, producing more uniform garbage corresponding to separate phases of the procedure, as opposed to a mixed collection from all parts. The predominance of extremity parts in Period 1 may also relate to bone working technology, since extremity bones, particularly the metapodials, provide some of the best raw material for this. There may in fact have been relatively more bone working conducted in Period 1 than at other times, with subsequent increase in extremity waste.

Sheep/Goat Parts

Appendix 17 lists the total NISP and associated frequency of the four categories of meat cuts for sheep/goats. Ribs and vertebrae have not been included in the calculations, for reasons explained earlier. Table 62 summarizes the information from Appendix 17 by listing the range and mean frequency for each of the four skeletal parts categories according to site type. Only sites with sheep/goat NISP sample sizes greater than 40 have been used in these calculations, the number of sites comprising each site type given in parentheses. As with the analysis of cattle parts, ranges amongst the various parts categories for sheep/goats are broad. The highest and lowest values within each categories are separated by more than 20%, and in a couple of cases this exceeds 50%. Again, the breadth in ranges underlines the fact that there will always be sites which do not conform exactly to any general pattern. I will examine this variation later. In order to identify such exceptions, however, I must discuss the typical scenario at each site type on the basis of average frequencies.

A comparison of mean values from Table 62 shows some aggregate patterning, with only minor variations. Heads predominate at all site types, ranging from 36.8% at urban1 sites to 46.3% at special sites. The extremity category registers the second highest frequency regardless of site; however, the data indicate that, compared to other skeletal parts, sheep/goat extremities are relatively less common amongst rural, special, and urban1 sites (range: 19.8-24.8%) than at urban2 sites (28.9%). Primary and secondary cuts consistently record the lowest frequencies. While in most cases their respective values are quite close, numbers from Table 62 indicate that secondary cuts are slightly more frequent at rural and urban2 sites. The reverse is shown for urban1 and special sites (i.e., primary cuts predominate over secondary cuts).

I attempted to standardize the three principal factors affecting the sheep/goat parts data—(i) numeric variation in skeletal elements comprising each category, (ii) taphonomic biases, and (iii) recovery biases—in a manner similar to that used for the cattle parts data. I retained the same dividing figure of "9" for the head category and "4" for the primary cut category, but modified the other two slightly on the basis of results of experimental work on the taphonomy of sheep/goat bones. Carnivore gnawing is perhaps the most common and destructive of all taphonomic agents. Both Brain (1976) and Payne and Munson (1985) have conducted tests measuring its effect on goat bones. Brain (1976) observed hyenas, so his results apply more to African than Italian environments. Payne and Munson's (1985) work has greater relevance to my analyses, since they observed patterns using dogs (common in Italy) instead of hyenas (not in Italy). They fed two uncooked adult goat carcasses, which had been stripped of meat, to dogs in order to determine which elements had a better chance of surviving the effects of intense carnivore gnawing. The authors concluded that "survival is high for the teeth, high for early fusing long-bone ends (e.g., distal humerus, proximal radius, distal tibia), moderate for metapodials, carpals and tarsals, and relatively low for late-fusing long-bone ends, scapula, pelvis, and phalanges" (Payne and Munson 1985: 35). I examined their evidence, pooling the data on individual bones into groups representing the four skeletal parts categories used in my analysis (i.e., heads, primary, secondary, extremity), and concluded that overall those bones associated with secondary cuts have a much better chance of surviving than extremity bones, which in turn have a greater chance of surviving over bones comprising primary cuts. To compensate for this difference, I increased the dividing factor for sheep/goat secondary cuts from "3" (as was used for cattle) to "4." The numerical disequilibrium shown in the fact that four bones (i.e., scapula, humerus, pelvis, femur) comprise "primary cuts," and only three (i.e., radius, ulna, tibia) "secondary cuts" in sheep/goats, is offset by the greater survivorship potential of the latter group over the former. Thus, I gave each the same dividing factor—"4." Payne and Munson's (1985) work also showed that sheep/goat extremity bones have a lower survivorship potential than bones associated with primary cuts. Moreover, they are smaller and consequently harder to recover than cattle extremities. I decreased the dividing factor for the sheep/goat extremity category, therefore, from "6" (as per cattle) to "5" to counteract these recovery and taphonomic biases.

Table 63 lists the mean values for sheep/goat parts from Table 62 as divided by the standardization factors outlined above. Only sites with sheep/goat NISP values greater than 40 have been included in these calculations, the number of sites given in parentheses after each site type.

The statistics in Table 63 show that some whole animals were certainly slaughtered at each site type since the standardized statistics do not vary excessively between site types or within parts categories. However, there are also discrepancies amongst the figures, indicating some degree of differential disposal (i.e., export/import) of sheep/goat bones. Rural sites have slightly fewer extremity bones than might be expected had whole sheep/goats been discarded. It appears as if these bones had either been disposed of elsewhere at the site (in areas unexcavated), or more likely exported, presumably with the animal's hide. In contrast to rural sites, urban2 sites have more extremity bones than expected, indicative of: (i) import of these bones (again likely with the hides), and/or (ii) export of heads, and primary and secondary cuts of sheep and goats. The relatively low value for primary cuts at urban2 sites suggests that at least these cuts moved elsewhere. A reverse pattern is shown at urban1 sites. Here, bones associated with sheep/goat primary cuts predominate, followed by extremities, with very few bones from the head and secondary cuts categories. Such a pattern suggests selective importation of caprine primary cuts, in addition to whole animals and carcasses. Finally, the data from Table 63 show that generally whole carcasses were disposed of at special sites, but with some addition of heads, and some removal of secondary parts and extremity bones.

Table 64 lists the standardized statistics for sheep/goat part mean frequencies on the basis of geographic area and site type. Again, only sites with sheep/goat NISP values over 40 have been used. Sample sizes are given in parentheses. Although there are differences in the sample sizes amongst the various categories in Table 64 the data indicate several patterns. Differential deposition occurs in all areas. Southern and central Italy have higher average statistics for secondary parts (4.9 and 4.7 respectively), compared to northern Italy (at 3.3). Central Italy claims the largest average value for primary parts (5.3), while corresponding values for southern and northern Italy are relatively small (3.7 and 3.8 respectively). Both primary and secondary parts are poorly represented amongst sites in northern Italy. The data also reveal a relative deficiency of sheep/goat extremity parts amongst sites in central Italy, but an excess of them amongst northern sites. It appears that sites in northern Italy are exporting caprine primary and secondary cuts (or less likely importing heads and feet), while those in central Italy are accumulating primary cuts. The fact that urban1 sites in central Italy have a particularly high average value for primary cuts (6.3) suggests that these cities requisitioned the bulk of such importation. Some primary cuts also seem to be leaving rural sites in southern Italy, where their value (3.4) is quite low compared to other parts. The data further indicate that sites in southern Italy are retaining (or perhaps importing) secondary cuts, on the basis of high overall values in this category. Little can be said about the special sites within each geographic region because the sample sizes are very small in each case. Nevertheless, available data reveal that special sites are quite erratic from the normal patterning. Those in southern Italy contain an abundance of primary and secondary cuts, which refutes the hypothesis that whole sheep/goats were always interred here. Instead, some extra cuts of meat seemed to have been deposited. The situation is reversed for the special site in central Italy (i.e., Lugnano cemetery). The data indicate that many more heads and feet were interred here, with the better cuts removed elsewhere. The special deposit from northern Italy contains an abundance of sheep/goat primary and extremity bones, again indicative of internment of select parts.

Finally, Table 65 lists the standardized statistics for sheep/goat parts as grouped by chronological period. Only sites with sheep/goat NISP figures greater than 40 have been included. There are a few general trends shown. First, the range amongst the statistics within each time period, although never quite marked to begin with, does diminish over time. The difference between the highest and lowest values in Period 1 is 1.2; Period 2—1.1; Period 3—1.0. This pattern suggests that relatively more whole sheep/goat carcasses were deposited during Late Antiquity than during Imperial or Republican times. The relative frequency of sheep/goat head elements gradually increases from Period 1 to Period 3, while a reverse trend for the same period is noted in the case of extremities. These patterns suggest some measure of differential deposition over time, wherein sheep/goat heads were progressively disposed of with the rest of the carcass, whereas earlier it was more likely that they were removed elsewhere. The high frequency of secondary cuts in Period 1 probably relates to an import of these elements to (or export of the other remaining cuts from) rural sites in southern Italy, which dominate this category (see Table 64). The value for secondary cuts drops between Republican and Imperial times. Values for the primary and extremity categories fluctuate in Table 65 with Period 1 recording the highest overall figure in the extremity group, and Period 2 the highest for primary cuts.

Pig Parts

Appendix 18 lists the total NISP and associated frequency of the four categories of meat cuts for pigs. Ribs and vertebrae have not been included in the calculations. Table 66 summarizes the information from Appendix 18 by listing the range and mean frequency for each of the four skeletal parts categories according to site type. Only sites with pig NISP sample sizes greater than 40 have been used in these calculations, with the number of sites comprising each site type given in parentheses.

The data in Table 66 emphasize the fact that there is great variation both between and amongst site types. The span between the greatest and least values is considerable, especially in the head category which averages a stretch of around forty percentage points for rural and urban site types. Ranges in the extremity category are also quite expansive. Rural and urban2 sites, for example, show nearly a forty point span. Again, such extensive ranges highlight the great degree of variation in bone samples, even between sites which may otherwise seem quite similar. I will examine this variation later. In order to identify atypical sites, however, I must discuss the typical scenario at each site type on the basis of average frequencies.

Analysis of the mean frequencies in Table 66 shows that heads clearly predominate, regardless of site type. Elements from this category account for an average high mean of 64.6% of all pig bones within special sites to a low of 43.8% at urban2 sites. The marked abundance of elements from the head of the pig, clearly displayed at rural and special sites, suggests a greater degree of differential deposition of carcasses at these sites. Pig heads were kept behind (or imported) while the rest of the body was removed elsewhere. Secondary cuts register the lowest mean frequency figures at all site types. Both urban1 and urban2 sites had substantially more bones from the primary cut category when compared to rural and special sites (20.5 and 18.4, as opposed to 14.4 and 12.5, respectively), thereby supporting the hypothesis that some better cuts of pork were imported into urban areas. Urban2 sites also contained a sizable proportion of extremity bones (23.9%) as opposed to the other sites types (urban1—17.3; rural—17.2; special—12.8).

The frequency figures for pig parts were standardized for taphonomic and recovery biases in the following manner. I am not aware of any experimental work in which the potential survivorship of pig skeletal elements has been recorded in a manner similar to what Brain (1976) and Payne and Munson (1985) have done for goats, but given the basic affinity of the pig and goat skeletons, it is assumed that results would be relatively similar. As with the goat skeleton, I would expect survival to be high for the pig teeth and high for early-fusing pig long bones (e.g., distal humerus, proximal radius), moderate for middle-fusing elements (e.g., distal tibia, metapodials) and compact bones (e.g., carpals and tarsals), and relatively low for late-fusing long-bone ends (e.g., proximal humerus, ulna, and femur). Some modifications are necessary, however. First, the adult pig's skull still retains highly visible suture lines, while most sutures are fully fused and no longer visible in the skull of an adult goat. Thus, pig crania may be more susceptible to disarticulation and therefore more prone to post-depositional destruction. Second, pigs have more teeth than caprines (and bovines), with the addition of six maxillary incisors, two maxillary canines and four first premolars (two maxillary and two mandibular, although these teeth do not always develop). Third, the limb bones, and especially the scapula and pelvis of pigs, tend to be stockier than those of sheep/goats and therefore may survive better. Fourth, the radius and ulna are fused along the shaft and distal end in sheep/goats, while they remain as separate bones in pigs. Thus, a low survival of pig distal ulnae may be expected. Fifth, the pig has retained the fibula as a relatively sturdy bone. Finally, there are in the pig double the number of metacarpals and metatarsals, which are short as compared to those of sheep/goats. Thus, these elements may survive less than their sheep/goat counterparts.

To compensate for these differences some changes must be made in the dividing factors. Recall that in the cattle analyses I divided the frequency figures for heads, primary cuts, secondary cuts, and extremities by values of 9, 4, 3, and 6, respectively. Corresponding factors for the sheep/goat analyses were: 9, 4, 4, and 5. Using these, and especially the sheep/goat numbers as a guide, I determined that factors of 12, 4, 4, and 6 would best approximate loss of pig parts through taphonomic and recovery biases. I added a digit for each new block of teeth to the base figure for sheep/goat heads (i.e., maxillary incisors [1] + maxillary canines [1] + mandibular first premolars [1] + maxillary first premolars [1] + base figure [9] = 13) then subtracted one (1) for the increased potential for pig crania to be destroyed for a total of "12." I retained the number "4" in the case of primary cuts (one digit for each bone: scapula, humerus, pelvis, and femur). I increased the secondary cut factor from "3" in sheep/goats to "4" in pigs to reflect the inclusion of the fibula. I concluded that the diminished survivorship potential of the distal ulna in pigs compared to sheep/goats would be balanced by the increased robustness of the other "secondary cut" pig bones (i.e., radius, tibia) in relation to those of sheep or goats. The new figure, therefore, remained at "4." Finally, I raised the extremity figure from "5" in sheep and goats to "6" for pigs to compensate for the doubling of the number of metapodial bones in the latter, but also taking into account the heightened chance these smaller bones might be more readily destroyed taphonomically or missed in recovery. Again, I stress that these standardization factors are basically a guide with which to interpret better the **overall, average** data on skeletal parts.

Table 67 lists the mean values for pig parts from Table 66 as divided by the standardization factors explained above. Analysis of the data in Table 67 informs us that there are differences in the average disposal pattern of pigs amongst each site type. The least variation between the values for the various pig parts is shown at urban2 sites, a pattern which suggests that these sites contained the greatest percentage of whole carcasses, with minimal import and export of pig parts. Some primary cuts may have been brought into these sites, on the basis of the fairly large figure in this category (4.6). Alternatively, head and secondary cuts may have been disposed of elsewhere at these sites, or exported to other types of site. Urban1 sites show a similar pattern to urban2 sites in terms of import and export. Some whole pigs were slaughtered in cities, but the data indicate substantial import of parts as well, especially primary cuts. If the figure for extremities is used as a base (i.e., 2.9) then, for every whole pig slaughtered at an urban1 site, bones associated with the primary cuts of another pig have been brought in (i.e., 5.1 is nearly double 2.9). Both rural and special sites have an excess of "head" elements compared to other site types. The data indicate that there was certainly some differential disposal of pig elements at both of these kinds of sites during antiquity. The export of cuts of pig meat, including the trotters, from these sites would be one way of producing the pattern shown in Table 67. This would leave the heads behind.

Table 68 lists the standardized statistics for pig part mean frequencies on the basis of geographic area and site type. Again, only sites with pig NISP values over 40 are included. Sample sizes are given in parentheses. While we must always be aware of sample size disparity amongst the categories in Table 68, a number of general comments can still be made about the data. Perhaps the most noteworthy observation is the general similarity amongst the pooled values for each geographic area. In the end, fairly whole pigs are accounted for, even though the constituent sites all show a marked degree of differential deposition and/or import/export activity. This pattern is best shown in northern and central Italy. For example, the predominance of head elements at rural sites in northern Italy (5.1) balances its corresponding low value at urban1 sites (3.7). Likewise, the dearth of primary cuts at these same rural sites (value of 2.8) offsets their abundance at urban1 sites in the same geographic area (value of 4.7). The overall figure for primary cuts at southern Italian sites is comparably low in relation to its central and northern counterparts, while central Italy yields the lowest percentage of pig extremity bones. Such a pattern suggests that better quality pig meat was consumed more often at sites in northern, and particularly central Italy, than in the south, where primary cuts account for a very small proportion of the averaged totals. The data for rural sites in southern Italy show export of primary and secondary cuts (values of only 2.2 for each compared to 4.9 for heads and 3.9 for extremities) but there are insufficient data to trace such an activity among the urban sites in this area. The sole urban1 site available (i.e., Otranto), however, shows a slight predominance of primary cuts, suggestive of meat importation. It is possible that southern Italy supplied urban sites in central and possibly northern Italy with quality cuts of pork. The values for primary cuts at urban1 sites in these two areas are relatively high compared to that for southern Italy (5.3 and 4.7, compared to 4.2). Rural sites in southern and northern Italy display a fairly common pattern: heads predominate, primary and secondary cuts trail far behind, while extremities fluctuate depending on the area. Rural sites in central Italy, however, have many more primary and secondary cuts than their counterparts, thereby suggesting more complete pigs were disposed of at these sites. Finally, special sites show quite unique distributions. Secondary cuts predominate in southern Italy, heads are most abundant in central Italy, while primary cuts register highest values in northern Italy. Sample sizes are very small for these special sites, however.

Lastly, Table 69 lists the standardized statistics for pig parts as grouped by chronological period. Only sites with pig NISP figures greater than 40 have been included. The data show some patterning. The values for primary cuts and secondary cuts all decrease from Period 1 to Period 2, then increase into Period 3. Numbers in the extremity category conform to a reverse pattern: increase into Period 2 followed by a sharp decline into Period 3. Clearly something unusual is happening between Periods 2 and 3 to cause such a dramatic change. The range between the highest and lowest statistics for both Period 1 and Period 2 is only 1.1 points, while that for Period 3 is a considerable 2.4 points. This suggests that far less differential disposal of pig parts occurred during Republican and Imperial times than during Late Antiquity. The predominance of primary cuts in Periods 1 and 3 indicates a concurrent excess of these better pieces of pork. This is especially noted during Republican times, when the value for primary cuts registers 4.6, the largest of all three periods. Waste products from the head are most prevalent at Period 3 sites, but this seems to occur at the expense of extremity bones which record very low values at this time. It is possible that there was increased export of pig trotters during Late Antiquity, or perhaps a change in pig butchery procedures to reflect a more compartmentalized routine, wherein different stages of the process occurred at different locations. In this manner, parts removed during the various phases of butchery might be more readily deposited at different locales.

Textual Evidence

While it may be true that the Roman diet was principally vegetarian (André 1981; Cherry 1993: 438; Dosi and Schnell 1986; Dupont 1989; Osborne 1996: 222; Quinn 1979: 134; Sirks 1991: 362; Vehling 1977: 30) there are numerous references in the Roman texts which show that meat too was certainly consumed as part of the Roman diet. Before analyzing these references in detail, however, a note must be made about Roman meals and Roman food in general, in order to provide a dietary context for meat consumption in antiquity.

Roman Meals

There are many publications which deal with the dining habits of the ancient Romans (Adkins and Adkins 1994; Carcopino 1941; Dosi and Schnell 1986; Guhl and Koner 1989; McLeish 1978; Paoli 1963; among others). Generally, the eating schedule of the Romans resembled our three meal system, even if the food is different. For most Romans, the first meal of the day was breakfast, or *ientaculum*. This often consisted of bread or pastry, sometimes with cheese, fruit, and water or wine. Meat was generally absent from the breakfast menu, regardless of the social class. Lunch, or *prandium*, was eaten around the middle of the day. It was a fairly light meal, like breakfast, generally composed of bread, perhaps with some cold meat or cheese, accompanied by olives, pickles or nuts, and followed by fruit. The main meal of the day, however, was dinner, or *cena*, eaten around dusk. It was more elaborate than the other meals, and especially so amongst the upper classes who used the meal as an ostentatious affair. The basis of the *cena* was meat or fish, with vegetables. Poorer families, who could not afford meat on a regular basis likely substituted this dish with gruel or vegetable stew. In addition, as Plautus (*Men.* 3.1.457-458) states, there were doubtless plenty of people who could only afford to eat once a day.

In reviewing the standard menus for each of the meals it is apparent that, for those who could afford it, meat was a potential component at lunch, and a relatively common, perhaps even central, part of dinner.

Roman Food

The Romans believed in dietary balance and therefore rated their food on the basis of nourishment and digestibility. Celsus (2.18.1-13) describes the various categories and places meat amongst them. Of the mammalian resources he rates the meat of all domesticated quadruped animals, all large game, such as wild goat, deer, wild boar, and wild ass, as well as cheese amongst the foods which are the "strongest" (i.e., provide most nourishment [Cels. 2.18.2]). These are further categorized. Pork is considered the weakest meat from domestic quadrupeds while beef scores as the strongest (Cels. 2.18.7). A similar scheme holds for wild animals—the larger the animal, the stronger the food it yields (Cels. 2.18.7). Middle-rated foods include hare meat, while no mammal resources are mentioned in the list of weak foods (Cels. 3.18.3). Celsus (2.18.8) further states that younger animals yield less nutriment no matter what their class rating. Likewise, the feet, lower cheek, ears, and brain of pigs, and whole heads and feet of lambs or kids are rated less nutritious than other parts of these animals, and subsequently considered as middle-class foods (Cels. 2.18.8). Wild animals rate lower than their domestic counterparts (Cels. 2.18.9) because fat meat has more nutriment than lean meat (Cels. 2.18.10). Fresh meat was considered superior to salted and stale meat (Cels. 2.18.10), while stewed meat was believed to be better than roasted meat, with boiled meat at the bottom (Cels. 2.18.10). Finally, Celsus (2.18.11) mentions milk as one of the most nutritious liquids.

Mammals in the Roman Diet

Aside from the list of recipes requiring various meats and animal resources in Apicius' cookbook, there are markedly few references to consumption of animal products in the ancient texts. The main mammalian species consumed were cattle, sheep/goats, and pigs. Wild animals were also eaten, but normally not equids, dogs or cats.

The texts provide minimal information about consumption of beef, veal, and other cattle products. Naevius (*Poems*, cf. Nonius 151.1) mentions tripe, steaks, and sweetballs, but is not specific as to the animal of origin. Apicius lists several recipes for veal (Apic. 5.1-4); beef is mentioned as a possible substitute for veal in only one of these (Apic. 5.2). Plautus (*Ps*. 3.2.834-835) provides some seasoning tips for beef, which were likely required, considering that beef was a relatively inexpensive meat (*Ed. Diocl.* 4.2 lists it at only 8 *denarii* per pound; most other meats were at least 12 *denarii* per pound). Cattle milk and cheese are sometimes mentioned in association with those of sheep and goats, but distinctive reference to consuming fresh milk is nearly exclusively made in the case of caprines (Ael. *NA* 36.31; Tib. 2.5.35-38; Mart. 3.58). The only reference to drinking cow's milk comes from Pliny (*NH* 25: 94) and relates to a somewhat unusual situation in Arcadia, Greece, where natural pasture was so lush that cows produced plenty of milk. In Italy, however, it seems fresh cow's milk was more of a rarity; Columella (6.24.4-5) alludes to reserving it for the calves. Cow's milk cheese receives brief mention by Varro (*Rust.* 2.11.3) and Apicius (4.1.1, 4.1.3). Varro (*Rust.* 2.11.3) notes that this cheese provides much nutriment but is difficult to digest, while Apicius' (4.1.1, 4.1.3) suggestion that this cheese be "cooled in the snow" hints that it was primarily, if not exclusively, manufactured at higher altitudes or northern regions.

The meat from sheep apparently held some importance in the Roman diet. Lamb is certainly preferred over mutton. Apicius (8.6.1-11) lists eleven recipes for lamb or kid and one involving mutton (Apic. 7.5.5), while Martial (5.37) boasts about the tender meat of lambs from Tarentum, in southern Italy. Moreover, mutton and goat's meat is listed at only 8 *denarii* per pound while lamb and kid, at 12 *denarii* per pound, cost substantially more (*Ed. Diocl.* 4.3, 4.47-48). Boiled sheep's head apparently was consumed by people of Jewish origin (Juv. 3.293-294), although other groups may have eaten it as well. Cheese made from ewe's milk does not seem to be as prevalent as lamb's meat in these recipes (Apicius lists only a few recipes involving sheep or goat cheese [Apic. 1.19, 4.1.2, 4.2.17]), although it probably contributed significantly to shepherds' diets (Frayn 1979: 39; *Moretum*, in Appendix Virgiliana, seems to describe a recipe for a sort of herb cheese). According to the Edict of Diocletian (6.95-96), both an Italian pint of sheep's milk and an Italian pound of fresh cheese carried a maximum price of 8 *denarii*, while an equal amount of dried cheese cost 12 *denarii* (*Ed. Diocl.* 5.11).

Apicius (8.6.1-11) includes eleven recipes that require kid or lamb but none for the meat of mature goats. Both Juvenal (11.64-72) and Martial (10.87) specifically mention a tender and plump kid as part of a feast, but again say nothing about eating mature goats. That goat meat did not contribute substantially to the Roman diet is also hinted at by Columella (7.7.2) who mentions slaughtering and salting these animals as a last resort for getting rid of diseased stock, after treatment or selling. Apparently, salted goat meat was not overly popular.

Pigs contributed the majority of meat to the Roman diet; their flesh was believed to be sweeter than all others (Ael. *NA* 9.28). Apicius lists more recipes involving pork, ham, and sausages than any other meat, not to mention those which required other parts of the pig, including the brains. There is a way to prepare every piece of a pig—from its entrails (Apic. 8.7.14) to its skin (Apic. 7.1.5) and from its head and neck (Apic. 2.1.5; 7.5.5) to its feet (Apic. 7.1.5)—as well as every age bracket from unborn in the womb (Apic. 7.1), through suckling (Apic. 8.7), to adult boar (Apic. 8.1) and sow (Apic. 4.2.14). The heart, however, is curiously absent from the list (Million 1926: 446). Overall, there is no literary evidence that livestock of any kind was deliberately reared for the table, except pigs. Pliny (*NH* 8.77.209) comments that no other animal provides a larger number of materials for the diet, and recognizes over fifty recipes involving pig meat. Petronius describes an assortment of upper class dishes, including sow's bellies (Petron. *Sat.* 36), roasted suckling (Petron. *Sat.* 40), white pig (Petron. *Sat.* 47), pig's head (Petron. *Sat.* 136) seasoned pig full of sausages and black pudding (Petron. *Sat.* 49), pig with honey cakes (Petron. *Sat.* 66), even animals carved from pig meat (Petron. *Sat.* 70). Other authors add to this feast of opulence: breast of sow and back of pork (Mart. 2.37), sow's udders (Mart. 7.78, 9.14, 10. 48, 11.52, 12.48, 13.44; Plaut. *Ps.* 1.2.166; Cels. 2.20.2: *Ed. Diocl.* 4.5), sow's matrix (*Ed. Diocl.* 4.4), sow's paunch (Juv. 11.138; Pers. 1.53; Hor. *Epist.* 1.15.41; Mart. 4.44, 13.56), smoked pig's cheek or *sinciput* (Pers. 6.69-73), Lucanian sausages (Mart. 4.44, 13.35; Apic. 2.4, 5.3.2, 5.3.8, 5.4.2; *Ed. Diocl.* 4.15), ham (Naev. *Comedies* 104, cf. Nonius 151.1; Plaut. *Ps.* 1.2.166, *Ed. Diocl.* 4.8-9), bacon (Lucil. 2.67-69, cf. Nonius 10.27), trotters (Celsus 2.20.2), and liver (*Ed. Diocl.* 4.6), not to mention regular pork (*Ed. Diocl.* 4.1a) and pork fat (*Ed. Diocl.* 4.10). According to Columella (7.9.4), farms which were near towns could often take advantage of the strong urban demand for sucking-pig, which was a popular delicacy (Mart. 13.41) and an ingredient in seventeen of Apicius' recipes (Apic. 8.7.1-17). There is even mention of ham offered as payment to a lawyer (Juv. 7.118; Pers. 3.73-75).

There is little literary evidence to suggest that other domestic mammalian species were consumed during Roman times in Italy. Horses were not normally eaten; only in sheer desperation were they consumed according to Tacitus (*Hist.* 4.60). Donkeys and mules also were generally not eaten, but there are some exceptions. Pliny (*NH* 8.69.174) notes that Africa boasts of its mule foals as an outstanding table delicacy known as *lalisa*. Martial (13.97) also recognizes the gourmet taste of young wild ass. Pliny further mentions (*NH* 8.68.170) that while Maecenas set the fashion of eating donkey foals at banquets, and they were much preferred at that period, after his time the ass lost favour as a delicacy. Finally, there is no mention of consuming dogs or cats amongst the Latin texts.[98]

Lastly, a variety of wild animals was eaten during Roman times in Italy. While the general idea was to hunt these personally, game could also be purchased at the market if required. It was fairly expensive. Boar meat, venison, wild goat, and roe deer meat fetched maximum prices of 12-16 *denarii* (*Ed. Diocl.* 4.43-45), unspecified amounts of rabbit and hare cost between 40 and 150 *denarii* (*Ed. Diocl.* 4.32-33), while dormice[99] sold for up to 4 *denarii* apiece (*Ed. Diocl.* 4.38).

Meat Diet and Social Class

While the texts provide a list of which animals were consumed and what parts of them were edible, they do not provide explicit details about how much meat was eaten, the relative proportions and cuts of all animals consumed, or how the contribution of meat varied amongst the sociocultural communities and geographic regions of Roman Italy. There was no standard "Roman food" eaten everywhere in the Empire; rather each country, region, and group had its own specialties. The information that does exist in the ancient texts, however, has a strong elite bias, which helps in distinguishing dietary differences amongst social classes. Martial, Petronius, and various other Roman authors and poets describe meals served at wealthy banquets, for what was eaten, where it came from, and how it was prepared were important criteria in defining the Roman elite. Such extravagant dishes and lavish dinners should not be viewed as characteristic of typical Roman consumption. The vast majority of Romans were probably quite poor; much of the detail regarding meat and animal products in their diets has escaped recording in the texts. Some information, however, can be gleaned from incidental comments and observations made by several authors. The agronomists, in particular, are a good source, while the writings of Plautus deal principally with common, rather than elite, characters.

Meat Diet of the Roman Elite

The basic differences which set apart the elite meat diet from poorer versions relate to the preparation and presentation of the dish, the variety of species consumed, and the quality and relative value of meat cut. Dining was a chance to display one's wealth conspicuously; therefore the Roman elite wishing to impress others flaunted expensive and extravagant dishes.[100] Roman satirists (e.g., Juvenal and Horace) and novelists (e.g., Petronius) both exaggerate and condemn this display of wealth.

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[98] Aelian (*NA* 4.40), however, makes reference to roasted dog flesh, but in the context of describing the keen powers of scent a dog has—"He is so keen-scented that he will never touch the roasted flesh of a dog, be it bewitched by the subtlest and craftiest of rich sauces"—and not specifically to human consumption of dog meat.

[99] It is unknown if these are dormice caught in the wild, or those raised in *gliraria* (i.e., specialized pots for keeping and breeding dormice). Presumably, it is the latter. Nevertheless, since dormice are naturally wild, I include them under "wild animals" for the purposes of dietary analyses here.

[100] Presentation was certainly a factor. Petronius' *Satyricon* is full of sumptuous and extravagant dishes, most of which would create quite a spectacle. In a letter to Marcus Aurelius, Fronto (*Ep.* 1.7.2) says that "no pot-herb, no bit of flesh is so cheap or commonplace a food as not to gain piquancy if served in a golden dish."

Wealthy Romans insisted on the most expensive meats. Euclio, a character in Plautus' comedy *Aulularia* (2.8.373-375) seeks lamb, veal, and pork, all "very dear" meats from the market. The Edict of Diocletian prices pork (*Ed. Diocl.* 4.1a), lamb (*Ed. Diocl.* 4.47), and kid (*Ed. Diocl.* 4.48) meat all at 12 *denarii* per pound. Sucking-pig (*Ed. Diocl.* 4.46), quality salt pork (*Ed. Diocl.* 4.7), sow's udder (*Ed. Diocl.* 4.5), sow's matrix (*Ed. Diocl.* 4.4), and liver of swine fed on figs (*Ed. Diocl.* 4.6) fetch higher prices (16-24 *denarii* per pound). Whole animals provided the most conspicuous display (Cic. *Fam.* 9.16.8).

Wild animals supplied variety to the wealthy diet. These could be hunted (numerous references to hunting) or purchased at urban markets (Juv. 6.38-40). Wild boar was a popular luxury dish in Roman Italy (Plin. *NH* 8.78.210, Petr. 40; Mart. 3.13, 3.50, 3.77, 3.82, 7.20, 7.27, 8.22, 9.14; Hor. *Sat.* 2.8.6-7, 5.114-119, 11.138-141), and apparently the bigger the boar, the greater the prestige awarded to its server (Mart. 1.43, 7.59, 9.48, 9.88; Hor. *Sat.* 2.4.40-42). Apicius (8.1.1-10) lists four preparatory recipes and six sauces for this delicacy, while both Martial (7.27) and Petronius (*Sat.* 66) comment on the "heavy" flavour of wild boar in comparison to other meats. It is more expensive compared to most other meats, but not incredibly so. The Edict of Diocletian (4.43) lists it at 16 *denarii* per pound. Pliny (*NH* 9.78.210) records that boars used to be cut into three parts with the middle part served as boar's loin. P. Servilius Rullus (63 BC), by serving a boar whole, initiated a trend which was a popular affair during Pliny's time when two or three boars were prepared just as the first course (Plin. *NH* 8.78.210). Juvenal (1.140-141) also notes the social significance of serving a whole boar.

While both rabbits and hares were certainly consumed during Roman times, hares in particular were prized for their meat which was considered a delicacy. Martial (13.92) rates it as the foremost of all quadrupeds, while Apicius (8.8.1-13) lists thirteen recipes for it. Moreover, hare, at 150 *denarii* (for an unspecified amount/weight), is one of the most expensive meats listed in the Edict of Diocletian (4.32). There are numerous references to eating hares (Petron. *Sat.* 36; Mart. 3.13, 3.47, 3.77, 4.66, 7.78, 12.48, Juv. 5.166-168, 11.138-141), with specific mention of hare's thigh (Mart. 6.75), hips and shoulders (Mart.7.20), and limbs (Hor. *Sat.* 2.8.88-90).

Other wild animals consumed included deer, gazelle, wild goat, and wild sheep. Juvenal (11.120-121) connects venison to wealthier diets. Presumably the other meats held similar status. Apicius includes seven recipes for venison (Apic. 8.2.1-7), three sauces for roe deer (Apic. 8.3.1-3), and a couple of recipes calling for wild sheep (Apic. 8.4.1, 8.4.3) in his cookbook. Venison, gazelle, wild goat, and roe deer meat are all listed at 12 *denarii* per pound in the Edict of Diocletian (4.44-45).

It is difficult to demarcate a rural and urban elitist diet since many of the Roman rich, no matter where they resided, could afford to import any luxury, and often spared no expense when it came to food. Nonetheless, the texts offer some clues. First, Martial (4.66) remarks that countrymen had much easier access to wild resources, which could be obtained without cost, compared to these same supplies sold at urban markets. While the Edict of Diocletian lists prices for wild game (*Ed. Diocl.* 4.43-45) and Juvenal (6.38-40) notes the possibility of purchasing wild game at the market, there are no specific details as to which markets, or in what quantities these resources were made available to urban dwellers unable to hunt.

Second, Columella (7.2.1) says that sheep provide much more than just milk and cheese to the menus of "people with taste." The contrast he makes with the milk and cheese for the "country folk" suggests that these are Roman elite in primarily urban settings. Thus, while still somewhat obscure, he implies that lamb and mutton might have formed a greater part of the urban elite diet than its rural elite counterpart.

Meat Diet of the Roman Poor

There is no mention of beef, veal, or pork consumption specific to Roman rural poor in the ancient texts. Presumably, these meats, especially the cheaper cuts of beef and pork, were eaten when available. The same is likely true for mutton and goat meat as well, with lamb and kid rarely consumed. The only textual references to animal products in rural diets come from Cato and Columella. Cato (*Agr.* 56-58) lists food rations for the slaves, overseer, housekeeper, foreman, and shepherd working at a rural villa. He is specific as to the grain, wine, and relish (including fish sauce) rations, but mentions nothing about meat. Columella (7.2.1) notes how sheep provided milk and cheese for "country folk," but he too says nothing of the contribution of meat to the rural diet. A further connection between cheese and "country folk" is made later on in Columella's manual (7.8.4).

Urban poor might have also obtained meat products from minced meat suppliers, *insiciarii* or *cocii offarii* (Isid. *Orig.* 20.2.26; Frayn 1993: 75 note 2). Macrobius (*Sat.* 7.8.1-2) comments on how difficult it was to digest minced meat, a feature which might have inhibited its purchase by discriminating elite. Many urban poor probably purchased sausages and other cheap snacks sold in cookshops in town (Hor. *Sat.* 2.4.58-62; Mart. 1.41.8-10, Juv. 11.81; Frayn 1993: 75). At 10 *denarii* per Italian pound, beef sausages were, on average, half the price of other prepared or specialty meats (*Ed. Diocl.* 4.14). Pork sausages were more expensive at 2 *denarii* per ounce (*Ed. Diocl.* 4.13), while smoked Lucanian pork sausages cost upwards of 16 *denarii* per pound (*Ed. Diocl.* 4.15). Pig brains are the most frequent ingredient in Apicius' sausage recipes (Apic. 2.1.4, 2.1.7, 2.5.1-4), and brains (likely pig but it is not always made explicit) occur as the sole animal ingredient in over a dozen stew-like dishes, casseroles, and stuffings (Apic. 2.1.5, 4.2.1, 4.2.4, 4.2.9, 4.2.21, 4.2.33, 4.5.3, 5.1.4, 5.3.2, 5.3.8, 5.4.5, 8.7.1, 8.7.3, 8.7.4). Celsus (2.22.1) includes the brains of all animals in his list of very bland foods. Pig's trotters and tidbits, as well as kid, calf, and lamb heads constitute other bland foods (Cels. 2.22.2), all of which might be considered base meats. Tertullian (*Ad nationes* 1.10.35) further indicates that these are relatively poor cuts of meat when he scorns sacrificers for offering only the worthless parts of the animal, specifically the head, hooves, feathers, hair, "and all that you would throw away at home."

Some meat may have been distributed to the public after an animal sacrifice. The Younger Pliny (*Ep.* 10.96.10) wrote, in a letter to Trajan, that the flesh of sacrificial victims was on sale everywhere, though up until recently scarcely anyone was purchasing it.[101] In addition, meat would have been periodically distributed in towns through the generosity of wealthy individuals or emperors, or as part of an imperial food-rationing scheme.[102] Not everyone received these rations, however. Juvenal (2.53) makes note of the selective nature of such schemes, and derides the crowds rushing to receive their daily dole of grain (Juv. 3.249-250). Persius (6.50-51) records a distribution of oil, bread, and meat to a crowd, in honour of the gods and the general (emperor?).

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[101] Religious doctrine prohibited Christians from knowingly buying and consuming sacrificial meat; however, according to another reference (St. Paul, I Corinthians 10.25, 28) the distinction between regular

Lastly, urban markets seem to have unfavorably exploited rural producers and drained them of their resources. Virgil (*Ecl.* 1.33-35) scorns the "thankless town" which received his animals and cheese.

Meat in the Military Diet

While meat was certainly a component of the army diet (Veg. *Mil.* 3.3; *SHA Hadrianus* 10.2; *P Oxy.* 2013-2014, 2046, 1920; Davies 1971: 138), the texts provide few details. They reference several methods of obtaining meat. First, armies could take or be supplied with meat from either local or distant regions (Caes. *B Gall.* 4.32, 5.17; Joseph. *BJ* 4.436; Tac. *Ann.* 14.24; Veg. *Mil.* 3.3; *CTh* 7.7.4). There are even records of family members sending food to soldiers (*BGU* 814 refers specifically to oil and meat). Second, armies may have kept and possibly herded their own animals on military lands (*prata*= meadowland specifically set aside for the military; Veg. *Mil.* 3.1, 3.8; *CTh* 7.7.3.1.4.5, 7.7.3.4.1.5; *CIL* 6.130 = *ILS* 2091, *CIL* 13.8174 = *ILS* 3265; *CTh* 7.4.7; Davies 1971: 123; Davies 1989: 248). Third, armies could purchase meat (e.g., *FIRA* 3.137; *CLA* 7, col. 1a, lines 6, 17, 27; col. 1b, lines 6, 17, 27; Davies 1971: 125, note 27). Finally, armies could hunt wild animals to obtain meat (*SHA Hadrianus* 2; *Dig.* 50.6.7.6; 16.12.1; *CIL* 13.8639; *CIL* 3.7449; *ILS* 3267, 9241; Veg. *Mil.* 1.7; Suet. *Tib.* 19; Davies 1989: 66, 248). Vegetius (*Mil.* 1.7) even recommends that butchers and hunters join the army, claiming them amongst the best soldiers.

With the exception of a number of battles during Republican times (e.g., Hannibalic and Social Wars as perhaps the greatest of these), Italy itself remained a fairly peaceful province until the Barbarian invasions of Late Antiquity. The bulk of the fighting, as the Roman empire expanded, took place in other areas such as Africa, Gaul, Britain, Pannonia, and the eastern provinces. Italy provided some meat rations for the army during episodes of war, but data are sketchy, and much of this relates to Late Antiquity. The Theodosian Code provides two such references. The first, dated to AD 355, states that whenever cured pork or perhaps fresh meat is issued to soldiers in Africa (the source of this meat is not made explicit) the government commands that only the heads and feet of pigs be removed. The rest of the pig must serve in the issue of the food supplies (*CTh* 7.4.2 [AD 355]). Another section of the Code makes reference to the relative amounts of food rations. Each soldier was to receive hardtack for two days out of three, bread on the third day; ordinary wine on one day, sour wine on the other two; pork on one day out of three, and mutton on the other two days (*CTh* 7.4.6 [AD 360]).

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and sacrificial meat was not always made clear to the client. Further information about the sale of sacrificial meat and its relationship to Christian and Pagan religions can be found in Corbier (1989) and Isenberg (1975).

[102] See Sirks (1991) for more discusssion of imperial-regulated food distribution systems involving meat.

The texts provide virtually no details about the economics behind the provisioning of meat rations to Roman armies. It is not known to what extent this was practiced or how much was made available, and how far animals or preserved meat would have traveled. Vegetius (*Mil.* 1.19) notes that soldiers were to carry their rations with their other supplies. Each soldier should expect to carry about 60 lbs of food and equipment. He further records that army provisions requisitioned from the provinces should be exacted in good time, and in sufficient quantities, and be stored at conveniently located but well-fortified posts (Veg. *Mil.* 3.3). Despite such precautions, food was sometimes wasted. Government officials outline in the Theodosian Code (*CTh* 7.4.1 [AD 325]) that they shall no longer tolerate deteriorating and decaying supplies unclaimed at state storehouses.

During episodes of war, animals would have been harder to maintain and obtain and presumably preserved meat was made available. A reserve supply could have been accumulated and stored for such an occasion (Veg. *Mil.* 4.7). Vegetius (*Mil.* 4.7) recommends that in the likelihood of a siege, pigs and other animals were to be slaughtered and preserved, but poultry should be kept because it was both inexpensive to maintain and beneficial for the sick. He further instructs soldiers to accumulate and store *laridum* (i.e., bacon fat or lard) to be used as a substitute for oil (Veg. *Mil.* 4.7; Davies 1971: 124). Overall, fresh meat would have been an infrequent contribution to the army diet during periods of war, unless armies were successful in battle. In this case they could expropriate farmlands or herds of animals and feast on these newly acquired resources.

Sumptuary Laws

Sumptuary laws designed to curb excessive spending were first introduced in Rome not later than the middle of the 2nd BC. According to Macrobius, the first of these, the Orchian Law, proposed in 181 BC, restricted the number of diners at a personal banquet (Macrob. *Sat.* 3.17.2, 5). A new, and more severe law, the Fannian Law, followed around 20 years later. It limited the permissible dining expenditure to one hundred *asses* on certain festival days, 30 *asses* on ten additional days, and only 10 *asses* on all other days (Aul. Gell. 2.24.3-6; Macrob. *Sat.* 3.17.2-5). In 141 BC the Didian Law bound the whole of Italy, and not just Rome, to sumptuary legislation, and extended penalty to not just the dinner host who broke these rules, but to the guests as well (Macrob. *Sat.* 3.17.6). The Licinian Law of c. 103 BC enacted that Romans might consume only thirty *asses* worth of food on the Kalends, Nones, and market days (Aul. Gell. 2.24.7-10; Macrob. *Sat.* 3.17.7-9). Moreover, meat consumption was limited to no more than 3 lbs. of dried meat *(caro arida)* outside of these days. The Licinian Law was followed in 81 BC by the Cornelian Law. This law placed no limit on extravagant dining, but rather seemed to encourage it by lowering prices on foodstuffs (Macrob. *Sat.* 3.17.11). In 78 BC, the Aemilian Law set a limit not on the expense of dinners but on the kind and quantity of food (Aul. Gell. 2.24.12; Macrob. *Sat.* 3.17.13). A few years later, another law, under the motion of Antius, further curtailed the outlay of goods, and made it illegal for magistrates to dine anywhere except at the houses of stipulated persons (Aul. Gell. 2.24.13; Macrob. *Sat.* 3.17.13). Other sumptuary laws were administered under Caesar (78, 71, and 46 BC) and later emperors (Aul. Gell. 2.24.14-15; Suet. *Aug.* 34.1; Frayn 1993: 125). Pliny (*NH* 10.139) makes some mention of these laws, while Tacitus (*Ann.* 3.52-55) notes that the emperor Tiberius refused to enforce such laws[103] since having been abolished by contempt they made luxury more secure (Frayn 1993: 125-126). Tiberius (Suet. *Tib.* 34) did legislate restrictions on what could be sold at *popinae* (i.e., places where prepared foods, including wine, were sold) and *ganeae* (i.e., places similar to *popinae* but with lower standards). Later emperors including Claudius (Cassius Dio 60.6.6-7), Nero (Suet. *Nero* 16; Cassius Dio 64.14.2), and Vespasian (Cassius Dio 65.10.3) also forbid the sale of meat at *popinae* and *ganeae* (Hermansen 1974: 168). However, to what degree these laws were enforced in and outside the city of Rome is unclear.

In addition to the sumptuary legislation, the ancient authors occasionally mention a sales tax on food (Seut. *Jul.* 40.2; Pliny *NH* 19.56). The details of this system are obscure and it appears to have been abolished in 60 BC (Suet. *Jul.* 43).

Integration

Both the zooarchaeological and textual data have their strengths and weaknesses when it comes to reconstructing the ancient Roman diet, which renders their combined analysis difficult along some lines. It is easier to draw conclusions about diet from a sample of bones than it is to infer aspects of animal husbandry. Many of the animal bones, at least those from the edible species of domestic and wild animals, derive from individuals which were ultimately consumed, and thus provide a direct link to the diet. The connection, however, is not necessarily easily interpreted, since consumer dietary choices are influenced by a number of cultural and natural factors prior to the disposal of bone rubbish, which itself is subject to taphonomic, sampling, and recovery biases that can alter these data and subsequently any interpretations drawn from them. The impact of all of these pre- and post-depositional factors must always be considered in dietary reconstructions.

Textual references also contain biases which hinder their use in dietary analyses. They document the species consumed, list prices for various animals, catalog methods on how to prepare certain organs or meat cuts, and provide social commentary about food in general, but they are not comprehensive in their recordings. While zooarchaeological and textual evidence overlap in the preliminary steps of dietary analysis such as identification of consumed species and their relative contribution to the diet, much of the subsequent analysis is one-sided. For example, the texts provide little information about specific meat cuts and their relationship to rural/urban or elite/poor diets, while zooarchaeology yields much more data on this topic. Conversely, the texts list and describe many culinary dishes which involve animals organs or products with either no, limited, or ambiguous zooarchaeological markers (e.g., milk, cheese, sausages, entrails, liver, etc.).

Although age and sex data for the principally consumed domestic mammals from Roman periods site in Italy were outlined and discussed in Chapter 5 they are also important in dietary analysis; therefore, I shall draw upon data from age and sex in this integrative discussion of diet. Herders and farmers choose ages and sexes for slaughter with stock propagation in mind. Normally, most males are killed at younger ages while females live to breed. However, a number of factors can modify this standard pattern.

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[103] Aulus Gellius (2.24.15) states that either Augustus or Tiberius increased the outlay for dinner on festival days from 300 to 2000 *sesterces* in an attempt to restrain luxury to at least that limit.

If Celsus' rating scheme was implemented assiduously by the Romans, then it follows that most people strove to obtain some type of dietary balance, but, considering the value of meal display to their social standing, could have been tempted to acquire solely higher-rated foods (assuming they could afford these). Thus, we might expect that the majority of Romans who had access to meat and desired optimum nourishment to consume freshly stewed, fairly fat, selected pieces from domestic animals. This may indeed have been a concern for many Romans, especially those on a tight budget with limited opportunity for acquiring specialized meat, and could have archaeological implications. Consequently, this pattern might be displayed in the zooarchaeological record by a predominance of bones from domestic animals of relatively large size; perhaps with some indication of stewing, such as absence of charring, decreased rates of bone survival, and maybe even traces of a broth or gravy on the bone acquired from the stewing process. Celsus' scheme, however, mentions little about the taste of the meat or animal product, and nothing of the expense involved in acquiring and preparing it. Those people who could afford all of the wild and domestic resources listed by Celsus probably did not worry about assiduously pursuing his dietary dicta. Wealthier diets, therefore, might be characterized by a greater variety of meats, prepared in different ways.

While zooarchaeological and textual data provide us with glimpses concerning the contribution and variety of meat in the Roman diet of Italy, it is impossible to quantify the demand for meat since this depends on the amount of available wealth and not on nutritional requirements (Morely 1996: 152). The quantity of meat eaten varied considerably amongst social class, between individuals, and likely over the seasons as well. Those with surplus income could always obtain both more meat and meat of greater variety. Without a means of measuring the amount of surplus wealth throughout Roman Italy, it is impossible to derive figures for the amount of meat consumed. Nevertheless, although absolute numbers may be elusive, important information about the role of meat in the Roman diet can still be extracted from an integrative analysis of zooarchaeological and textual data on the subject.

Mammals in the Roman Diet

Wild Mammals

Martial's (4.66) claim that countrymen have easier access to wild resources than urban dwellers is verified in the zooarchaeological data. As shown in Tables 14 - 19 wild animals are represented at about three-quarters of the rural and urban2 sites, but less than half of the urban1 sites. In terms of meat contribution, the data from Table 53 show that the average rural site registers c. 90% domestic meat and c. 10% wild meat, as opposed to mean values of c. 98% and c. 2%, respectively, for urban1 sites. Urban2 sites lie in between this range with c. 92% domestic meat and c. 8% wild meat. Although the zooarchaeological data indicate that wild meat was never consumed in any significant quantity when compared with that from domestic animals, they do show that the average rural site consumed about four times more wild meat than its average urban1 counterpart, and about twice as much in relation to the average urban2 site.

The texts are not specific about the ideal relative proportions of domestic and wild meat in the Roman diet. Availability, price, and the nature of the feast presumably dictated if, when, and how much wild meat was consumed. Wild resources were generally luxury foods. Venison is specifically connected to wealthier diets in Juvenal's (11.120-121) writings. Wild hare was an expensive delicacy (Mart. 13.92; *Ed. Diocl.* 4.32), while wild boar is often mentioned in the context of ostentatious feasting (Plin. *NH* 8.78.210; Petron. *Sat.* 40; Mart. 1.43, 3.13, 3.50, 3.77, 3.82, 7.20, 7.27, 7.59, 8.22, 9.14, 9.48, 9.88; Hor. *Sat.* 2.4.40-42, 2.8.6-7, 5.114-119, 11.138-141). Thus, we might expect the presence of at least these three wild taxa at many of the archaeological sites in Italy, most of which show signs of wealthier occupation. The zooarchaeological data indicate that this is generally the case. Deer, wild hare, and wild boar are the most popularly represented wild animals for all sites. Red deer predominate, followed by roe and fallow deer. Apicius echoes this order in terms of the number of recipes for deer, with seven for red deer (Apic. 8.2.1-7) but only three for roe deer (Apic. 8.3.1-3). Fallow deer are not specifically mentioned in Apicius' cookbook.

Hare was a great delicacy in Roman times, and could be obtained in two basic ways. First, it could be hunted, and there are many references to this activity. Hunted hares were probably consumed more often in rural locales, considering proximity to the forest. This pattern is verified in the zooarchaeological record. Hare bones are more common at rural and urban2 sites than urban1 sites. This is expected in light of textual references to hare hunting in the countryside, as well as the association of special game preserves for raising hares (called *leporaria*) with wealthy rural villas (Varro *Rust.* 3.3.3, 3.12.4-7). However, the presence of hare at urban1 shows that these animals were either hunted by urban dwellers and brought back to the city, or purchased at urban markets. Considering the time and expense involved in hunting (not to mention the potential to come back without a catch), I suspect that most of the hare consumed in cities was bought there at the market. Many of these hares were probably raised in *leporaria* in suburban areas. A *leporarium* has even been identified from excavations at Settefinestre (Carandini 1985).

The topic of wild game preserves in Roman Italy is complex. On the basis of Varro's (*Rust.* 3.3.2-8, 3.12-13) writings it would seem that, amongst mammals, hares were first to be raised in this manner, but that gradually into Imperial times the concept expanded to include other wild mammals. They seem to have reached their pinnacle at the height of Roman culinary ostentation and excess during early Imperial times. Wild game preserves are a class within a type of farming known as *pastio villatica*, or the rearing of special animals for "both pleasure and profit" (Varro *Rust.* 3.3.1). The other two classes of *pastio villatica* are the aviary and fishpond (Varro *Rust.* 3.3.1). Wild game preserves were themselves divided into two categories: (i) expansive establishments for larger taxa such as wild boar, deer, hare, etc., and (ii) smaller contained structures for raising snails, dormice, and bees (Varro *Rust.* 3.3.3).

The relative lack of wild boar bones in relation to other wild animal species stands in contrast to this animals' rather ubiquitous mention in the ancient texts. It is possible that more wild boars are represented but have been identified as pig. The skeleton of the wild boar differs from its domestic pig counterpart in several ways. Wild boar bones are usually larger and stouter than those of domestic pigs. Generally, their measurements give withers (or shoulder) heights within the 90-100 cm range, compared to average heights of 70-80 cm for domestic pigs (Payne and Bull 1988). Size, however, is not always the best separator since it is heavily dependent on nutrition, health, and choice of breeding stock. This dividing line is further blurred in areas where wild and domestic pigs interbreed, a practice which even the ancient authors noticed (Plin. *NH* 8.79.213). Skull and dental morphology better indicate species' origin. A wild boar has an elongated skull which is straight in profile, while a domestic pig's skull is incavated and short in profile (Nishimoto 1994). Wild boar molar teeth are generally longer and larger than those of domestic pigs, and although both types have canine teeth, or tusks, those of the mature male wild boar are often relatively more massive (Nishimoto 1994).

Zooarchaeologists generally use a combination of these criteria to distinguish wild boar and pig remains, although the skull elements, perhaps the best separator, rarely survive in the archaeological record because of their delicate nature. Teeth are often used since they are durable and fairly reliable indicators of species, while graphical plots of other bone measurements, interpreted in light of biasing factors, can help to distinguish wild boar and pig post-cranial remains (Payne and Bull 1988). Unless measurements are taken and reported, which is the case for about one-third of the sites used in this analysis, it can be difficult to differentiate wild boar from domestic pig bones. This in part may explain why fewer wild boar remains were noted at Roman period sites in Italy than might be expected on the basis of textual evidence. They simply were not distinguished morphometrically from domestic pigs.

The relative absence of rabbit bones from Roman period sites in Italy might be attributed to several factors. First, the texts do not always distinguish between hares and rabbits, and the same sometimes applies in zooarchaeological identification, with both species lumped into a single category. Second, although Varro (*Rust.* 3.3.3, 3.12.4-7) recognizes that hares and rabbits could be kept in special game preserves, the name for these complexes—*leporaria*—suggests that they were originally, and perhaps principally, intended for hares. Hares are larger and would provide more meat. Finally, it is assumed that rabbits spread from Africa to Spain, Corsica, Sardinia, and Sicily before eventually reaching Italy in the early third century AD (Naether 1967). Varro (*Rust.* 3.12.7) even comments about rabbits following people from Spain to other parts of the Roman world. The fact that relatively more rabbit bones have been recovered from Late Antique deposits in Italy (e.g., San Giovanni, Lugnano cemetery) than those of earlier contexts accords with this pattern of introduction and proliferation. The odd rabbit may have existed (or been imported) in Italy prior to the species' general introduction and spread in the third century AD. Rabbit bones are reported from Republican period sites in southern Italy such as Metaponto-kiln. These may not date to that early time period, however, and could represent contaminants from burrowing rabbits at a later time.

Age information for wild animals was infrequently presented in the site faunal reports, and sex data even less so. What are available, however, tend to support textual references hinting that mature wild animals, usually males, were consumed. Deer antlers and wild boar tusks (i.e., canine teeth) indicate males, but hunting cannot always be confirmed.

Shed antlers were certainly collected for other purposes, and are noted at some sites (e.g., Gravina, Lugnano). Nevertheless, hunting majestic and fierce adult male wild animals likely carried great prestige, which was certainly part of the ostentatious nature of this sport.

Meat weight statistics at several sites stray markedly from the mean values as reported in Table 53. Quintili, Lugnano-period 3 villa, and both Via Gabina sites (site 11 and site 10) register very low (or non-existent) wild animal meat-weight frequencies compared to the average values for rural sites within the same geographic and temporal grouping, while the reverse is shown (i.e., low domestic, high wild frequencies) for Lugnano-period 2 villa, Settefinestre-period 3, Santa Maria la Nova, and to some extent San Giacomo. MNI sample sizes are small at several of these sites—notably Lugnano, Via Gabina site 10, and Santa Maria la Nova—making it difficult to discount this bias in these cases. Samples, however, are large enough at the other sites to introduce other explanations for the patterns presented. It is possible that fewer wild resources were available at the Via Gabina sites and Quintili because of the concentration of settlement in the region around Rome. Both of these sites are within a 50 km radius of Rome. Less forested, or at least uncultivated land existed in this area, compared to more remote parts of Italy. It follows, therefore, that fewer wild animals would be available, considering their habitat would be reduced.

An alternate explanation for the lack of wild animals at suburban sites like Via Gabina and Quintili is that these places specialized in another aspect of production such as flowers or fruit trees. The economics of suburban villas is complicated. Individual cases are much too difficult to reconstruct fully on the basis of limited archaeological and textual data. Some owners likely chose to make their suburban properties pay by practicing *pastio villatica* or other methods of farming; others kept them as places to retreat from the pressures of work. "At times production and consumption were combined; at other times they were in fierce competition" (Morely 1996: 94).

The general popularity of wild animals among sites in Tuscany, with Settefinestre-period 3 as a prime example, and Le Colonne, Settefinestre-period 2, and Monte Gelato-period 2 as supportive evidence, accords with Pliny the Younger's (*Ep.* 5.6) statement about the abundance of game in the hills and mountains of this area. Not surprisingly, other sites located in fairly rugged or mountainous areas with forests (e.g., San Potito, Colognola, Monte Barro) record fairly high wild animal frequencies. Even the ancient authors recognized these areas as important game-producing zones (Verg. *Ecl.* 5.76; Petron. *Sat.* 40; Mart. 4.66, 12.1; Ov. *Fast.* 2.231-233; Calp. *Ecl.* 7.58; Prop. 2.3.5-6; Tib. 3.9.1-4; Macrob. *Sat.* 1.21.4). However, there are also many exceptions. The forests of northern Italy (Calp. *Ecl.* 7.58) and those of Lucania (Hor. *Sat.* 2.3.234-235) are especially named as boar producing areas, but this is not particularly supported by the zooarchaeological evidence. In fact, fairly low frequencies of wild meat are noted at San Giovanni-period 3 which is located in the Lucanian highlands, as well as at several sites in northern Italy (e.g., Modena, Torcello, Altino, Villa Clelia).

Neither the texts nor the zooarchaeological data provide information to judge the contribution of wild meat to the rural peasant diet. A rural peasant operating a subsistence-level farm probably relied heavily on staple cereal foods and supplemented this with foodstuffs which could be gathered and added to the diet at no extra cost. Frayn (1975) argues that rural peasants consumed both wild and cultivated plants in their diet, but makes no reference to the contribution of wild and domestic meat. If wild animals were consumed as supplemental resources in the diet of the rural poor then it is possible that individuals had limited choice. Compared to the elite, the Roman poor might not have had the time, energy, equipment, or legal right[104] necessary to capture large game. Consequently, they might have had to resort to smaller wild animals, such as hare, and rabbit[105] in later times, or prey upon feeble, young, or less impressive members of larger species.

Originally, pastoral shepherds and nomads may have supplemented their share of meat, certainly caprine-based from their own flocks, with that obtained from wild animals which they encountered in their transhumant journeys (Dosi and Schnell 1986: 83). If he had killed a dangerous animal as legislation permitted (*CTh* 15.11.1), then it is unlikely that a rural peasant or transhumant herder would leave the carcass if the animal could be consumed or otherwise utilized.

The whole topic of wild animal resource availability in antiquity hinges on environmental reconstruction, particularly the amount of forest cover. While deforestation certainly occurred throughout Roman times in Italy, a complete reconstruction and discussion of ancient environments is outside the scope of this thesis.[106] The fact that Republican period sites generally record greater wild meat frequencies suggests that Italy was more forested at this time. However, this is expected considering the region was certainly less populated during the Republic. The progressive decline in wild animal mean frequencies over time amongst rural sites in central and southern Italy suggests steady deforestation in these areas, again likely the result of agricultural expansion and a growing population. Faunal evidence for northern Italy supports dramatic deforestation from Republic to Imperial times with some reclamation during Late Antiquity.

Domestic Mammals

It is clear from both the zooarchaeological data and the ancient sources that domestic mammals constituted the bulk of the meat in the Roman diet of Italy. A number of points concerning the zooarchaeological data from Figures 23 - 24, and Tables 53 - 57 are worth reviewing. First, cattle account for more than one-third of the domestic meat consumed at nearly all rural, urban1, and urban2 sites. Caprines contribute relatively little meat to the Roman diet of Italy, generally less than 20% of the domestic mammalian meat consumed, while pig values fluctuate substantially, especially over geographic regions, but usually account for more than one-third of the meat eaten. Second, although there are individual exceptions, the general pattern shows beef to be most abundant in the diet of the Romans in northern Italy, with central, and southern Italy trailing in that order. The situation is usually reversed for sheep/goats and pigs, which register their higher average values in central and southern Italy. A third point is that while beef regularly accounts for half of the total meat weight among sites in northern Italy, cattle meat weight values fluctuate over time, and are generally at their lowest during the Imperial period. On the contrary, sheep/goat and pig mean meat weight frequencies among sites in northern Italy are normally their highest during Imperial times compared to other periods. Fourth, cattle and caprine meat weight frequencies decline fairly dramatically over time at rural sites in southern Italy, while pigs show a concomitant increase. A fifth point is that cattle, and to a lesser degree caprines, contribute progressively less meat over time among most sites in central Italy, while the frequency of pigs in the diet in the same area increases. Pork accounts for, on average, about half the domestic mammalian meat consumed during Imperial times in central Italy, amongst its largest values for the whole country. Finally, the zooarchaeological meat weight data show that most rural and urban2 sites consumed relatively more beef, and to a lesser extent mutton and lamb, than their urban1 counterparts. This pattern is switched in the case of pork, with urban1 sites registering higher pig meat weight mean frequencies than corresponding rural or urban2 sites.

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[104] The ancient laws concerning ownership of wild game are not always clear. Wild animals in a private *vivarium* or *leporarium* (assumed to be walled or otherwise enclosed) belonged to the owner of that preserve. However, those not contained in a reserve essentially had no owner and effectively became the property of the taker as soon as they were caught regardless of if this occurred on one's own or someone else's land (Just. *Inst.* 2.1.12). A landowner could certainly warn people off his estate, and most hunters probably limited such confrontations by restricting themselves to their own, or invited, territories. In any event, hunting big game required large tracts of land. Since most of the land in Roman Italy was owned by the wealthy or the state it follows that the rich and powerful essentially had greater access to the game animals contained therein. Furthermore, the hunting treatises of Grattius and Nemesianus, which outline methods to capture large game, are both intended for an elite audience. Anderson (1985) and Green (1996) provide further information about the social and practical aspects of Roman hunting. Neither, however, considers the zooarchaeological data.

[105] Dosi and Schnell (1986: 84) state that hares became four times more expensive as rabbits, and that the latter were often reserved for plebeian consumption.

[106] This is a very complex topic, and any "complete" reconstruction is impossible. See note 14 above.

Aging and sexing data provide more information about the ancient diet. A predominance of older cattle, both males and females, is generally noted amongst all sites. Older oxen outnumber mature cows by ratios of approximately 2 to 1 and approximately 3 to 1 at many sites where the two co-exist. However, three sites—San Giovanni-period 3, Pozzuolo del Friuli, Innichen—contain significantly more older cows than oxen, implying some degree of dairying. Although the vast majority of cattle survived beyond two years regardless of site type or region, available fusion and dental data indicate that relatively more calves were killed at sites in the north than elsewhere in Italy.

A review of sheep/goat aging and sexing data indicates that older female sheep largely predominated at most sites in southern Italy (e.g., Gravina, Cozzo Presepe, Otranto), but maintained a minor lead over males amongst sites in the north (e.g., Stufels, Invillino, Innichen). Rural sites tend to record relatively more female sheep/goat than do urban2 sites, but there are insufficient data to draw comparisons with urban1 sites. Dental aging schemes show that, on average, about half of these animals was killed between the ages of one and four years at urban1 sites, with nearly two-thirds killed within the same age bracket at rural and urban2 sites. An average of c. 30% of the sheep/goat died at less than one year of age amongst rural and urban2 sites, with relatively fewer young lambs and kids (c. 20%) registering at urban1 sites. Excluding special sites, urban1 sites report the greatest mean value for sheep/goat deaths beyond four years of age, at c. 21%.

Male pigs tend to outnumber females at most sites, but are most abundant at urban1 and urban2 sites, which average a ratio of about two male pigs for every female compared to about 1.3 male pigs for every female amongst rural sites. Sites in northern Italy consistently claim high percentages of male pigs; central Italy lags only slightly behind, while, on average, sites in southern Italy yield the lowest frequency figures for male pigs. Dental aging data shows that, on average, about one-third of the pigs at all site types were killed before attaining one year of age. Another third is killed between 1-2 years with the last killed at beyond two years amongst urban2 sites. A similar pattern, but with slightly fewer deaths in the 1-2 year range and slightly more in the >2 year range is shown for urban1 sites. At rural sites, however, about half of the pigs are killed between 1-2 years with less than 20% killed when older than two years of age.

The texts provide little information with which to supplement or test these zooarchaeological dietary data. Northern Italy is referenced as prime cattle-raising territory, therefore it stands to reason that beef would be more readily available to occupants here. However, the ancient sources are short on facts about how this may have changed over time. Beef was a relatively inexpensive meat, at least during Late Antiquity (*Ed. Diocl.* 4.2), and on the basis of its high frequency values I would predict this was also the case during Imperial and Republican times as well.

The relative dearth of references to beef and veal in the ancient texts stands in contrast to its large meat weight values in the zooarchaeological data. While beef may not have been preferred—Apicius lists relatively few recipes for beef compared to pork or lamb—perhaps it was consumed more out of necessity, perhaps as insignificant and common sausage beef rather than as choice cuts of meat. Celsus (2.18.7) rates it as the most nutritious of meats, and at only 8 *denarii* per pound it was relatively inexpensive as well (*Ed. Diocl.* 4.2). The higher proportion of calves amongst sites in northern Italy is to be expected if these sites raised herds of cattle. In this case, deaths would not reflect the demise of the occasional work oxen or dairy cow, but might reflect the husbandry and dietary decisions of the occupants. They could kill select younger animals and enjoy the tastier, more tender meat they provided. If performed judiciously this would not impair the reproduction of the herd, assuming it to be relatively large. A similar option would not be available to ranchers keeping only a few cattle, or those choosing to raise a small herd of them to mature ages for draft and/or breeding purposes.

The zooarchaeological data confirm the textual references concerning the popularity of pork in the diet. This pattern is especially apparent amongst Imperial and Late Antique sites in southern and central Italy, where pigs contribute an average of about one-third to one half of the domestic meat weight, depending on site type and quantifier (i.e., NISP or MNI). Corresponding values for sites in the north are generally less than one-third of the meat. The increase in pork consumption over time corresponds to changing dietary and agricultural programs. As the Roman animal economy shifted from one principally based on pastoralism during the early Republic to one where mixed farming and market-oriented husbandry schemes gained prominence during Imperial times and into Late Antiquity we would expect to see a decline in sheep/goat and cattle meat in the diet with a concomitant increase in pork consumption. Moreover, such a shift indicates that meat was important to, or at least desired in, the Roman diet. If it was not, then a change towards greater production of pigs would not occur. Pigs provide no other major resource besides meat.

The zooarchaeological data indicate that mutton and goat meat were not consumed by the majority of sedentary farmers but were presumably important to pastoral economies. As such, sheep and goat contribute relatively more meat to the diet during the Republic, at least in southern and central Italy where the landscape is generally more conducive for pastoralism. Moreover, the zooarchaeological data support textual references about the popularity of sheep meat over goat meat.

While calculating mean frequencies from zooarchaeological data will smooth over individual differences amongst sites, it is necessary in order to identify outliers, and to determine to what degree they deviate from the norm. A number of sites as shown in Appendices 14 and 15 deviate from the average patterns shown in Figures 23 - 24 and Tables 53 - 57. In many cases the differences between the reported frequencies for any site and the average values given in Tables 55 and 57 are less than 20% for cattle and pigs (which tend towards higher values to begin with) and less than 10% for sheep/goats; however, in a few cases the differences are quite marked. I outline several of these below and offer some possible explanations for their discrepancy from mean values. I shall only discuss sites where the NISP and MNI patterns for meat weights were consistent.

- **Gravina pit:** This deposit contains very little cattle and elevated frequencies of both sheep/goat and pig compared to the average for S/1/r sites. Moreover, many of the sheep/goats are young lambs, while a sizable proportion of wild meat is noted as well. The sample likely represents waste from a relatively wealthy or privileged diet.

- **San Omobono:** Cattle account for less, and sheep/goat for more of the meat than expected in this sample. It is possible that sheep/goats contributed significantly to an animal sacrifice at this site, thus explaining their elevated meat weight values.

- **Carminiello-period 1:** This site registers more pig and less sheep/goat and cattle compared to mean values. Pork may have been easier to import to this urban area or more readily available for slaughter, with sheep/goats and cattle reserved for other purposes.

- **Pompeii, Ganimede:** A reverse pattern than that shown for Carminiello-period 1 occurs at this site. Cattle predominate with very little meat being contributed from sheep/goats and especially pigs. Beef may have been preferred in the diet here, but it is also possible that its values are relatively high because more sheep/goat and pig bones were destroyed taphonomically.

- **Quintili:** Pigs largely predominate in this deposit while cattle do not figure at all. This situation is similar to that for the site of Gravina-pit above in being waste from a special diet. Considering the Quintili deposit is mainly pig, a wealthier consumer seems justified. Moreover, cattle may have been scarce in this area especially if the land was given over to agricultural pursuits which did not require extensive use of them such as fruit tree or vine growing.

Body Parts

Integrating zooarchaeological and textual data about skeletal parts is plagued by both a great imbalance in the amount of data each field yields and a series of troublesome unknowns. The texts provide little specific information. In several cases they imply a transfer of whole animals from rural to urban areas. Whole animals were essential to ostentatious culinary displays (Cic. *Fam.* 9.16.8; Juv. 1.140-141; Plin. *NH* 8.78.210), and surely had to be available for urban elite. The fact that Apicius instructs his readers to clean, gut, and disembowel animals such as sucking-pig (Apic. 8.7.1-5), kid (Apic. 8.6.11), and hare (Apic. 8.8.9-9) implies that at least these could be purchased whole and subsequently prepared. Varro (*Rust.* 3.2.11) distinguishes between the *lanius* who slaughters the animals and the *macellarius* who prepares and sells the meat, but by separating them both from the landowner and farmer he implies that they reside in urban communities. The *lanius* would receive whole, live animals presumably from rural areas. Columella (7.9.4) adds that farms near towns should take advantage of the strong urban demand for sucking-pig. Although Columella is not specific, whole piglets were likely transported, and probably slaughtered at urban locales, depending on the circumstances.

While whole animals were certainly moved from rural to urban areas, the texts give practically no information about the distribution of skeletal parts amongst various site types. There is no mention of rural sites retaining waste products and exporting better cuts of meat to urban areas, nor is reference made to urban sites importing quality meat cuts. The fact that Celsus (2.18.8) ranks the feet, lower cheek, ears, and brain of pigs, and whole heads and feet of lambs and kids as less nutritious parts of these animals, implies some ordering of meat cuts, but also shows that even these less-favoured sections were consumed. The long list of pig products amongst Apicius' recipes shows that every part of this animal was eaten, from its trotters to its head. Although some parts of the pig like its udder or belly, as well as certain age groups, notably younger sucklings, are generally mentioned in relation to gourmet feasts, others such as sausages and trotters show up in the cuisine of both rich and poor. Moreover, relatively poorer cuts of meat could be seasoned with expensive ingredients thus producing a gourmet dish. Alternatively, choice cuts of meat might be stripped from the bone, with the remaining bone and meat scraps still attached subsequently sold at a much reduced price. In this manner, bones associated with prime meat cuts might comprise a large component of "lower-class" waste.

Zooarchaeological data provide more information than the ancient sources about the distribution of skeletal parts and its relationship to diet and trade. However, the same two problems described above (i.e., making "poorer" cuts gourmet, and incorporating devalued bones from better cuts of meat into "poorer" waste) apply. Both of these are difficult to recognize. Filleted meat would not show in the archaeological record since the bones would be disposed of elsewhere.[107]

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[107] Studying butchery marks may assist in recognizing this problem. A predominance of knife lines and other marks from filleting meat shown on bones associated with better-quality meat would indicate meat had been stripped from the bone. However, as reported in the section on "butchery" earlier in this chapter, there are insufficient data to test this hypothesis, not to mention further complications associated with the deposition and recognition of knife marks on bones.

The zooarchaeological data for cattle parts indicate that some whole animals were certainly killed, consumed, and disposed of at all types of site. The mean values for the skeletal parts are fairly close amongst rural, urban2, and special sites; however, the fact that discrepancies exist indicates differential disposal and/or export/import of skeletal parts. Urban1 sites, on average, claim an excess of extremity bones as well as bones associated with primary cuts of beef than would be expected had only whole cattle been disposed. At the same time there is a dearth of bones from cattle heads. This pattern requires explanation. The relative lack of bones from the heads might be a factor of transporting cattle carcasses into urban areas without their heads. The cattle head is generally the first part of the body removed after the animal is slaughtered and drained of blood, and it is normally detached prior to gutting and butchering the carcass. Not much can be done with the head. Compared to that of the pig, the cattle head contains little edible muscle tissue, aside from the brain and tongue which are, and likely also were, less popularly consumed compared to post-cranial cuts of beef.[108] The horns might be used, but these can be easily sawn or cleaved from the skull, leaving the rest of the cranium and mandible behind as waste. It is possible then that relatively more cattle heads were disposed of at production sites alongside slaughter waste, thereby allowing fewer to enter urban markets where they might later be sold to consumers.

While the zooarchaeological data indicate that relatively fewer cattle heads were brought into urban centres, they also show that more primary cuts and extremity bones were imported. Extra primary cuts of beef may have been imported to towns to supply a demand for better-quality meat. Several urban1 sites—Carminiello, Schola Praeconum, Saepinum, Naples-Via San Paolo, and Altino—register above average frequencies for primary cuts and in many cases secondary cuts, but contain few bones from cattle heads or feet. The impression is that cattle remains from these sites in particular represent, in great part, waste from the latter stages of beef preparation and cooking, rather than slaughter or initial butchery waste. Furthermore, an excess of primary cuts suggests an elite diet.

The predominance of extremity bones among urban1 sites compared to rural and urban2 sites might relate to processing and tanning hides. Although skins are delivered to modern tanneries without bones, zooarchaeological evidence indicates that this was not the case in the past (Serjeantson 1989: 136). Disproportionately high numbers of foot bones have been noted at a number of Roman, medieval, and early-modern sites in Europe.[109] Serjeantson (1989: 137) notes that this pattern is often displayed at urban sites, and adds that the tanner may have wanted the feet in order to extract neatsfoot oil from them.

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[108] Although beef tongue and brain can be delicacies, they are not regularly preferred over other beef parts. Post-cranial cuts dominate contemporary supermarket displays, and a similar situation is assumed for Roman Italy. Apicius makes no specific mention of cattle brains or tongue in his recipes, which supports the hypothesis that they were not popular meats. Moreover, pig's tongues are not included amongst the long list of pig recipes (which includes nearly every other part of the pig's body), while brains are only referenced in relation to sausage fillings (Apic. 2.1.4-5, 2.5.1) or relatively cheap stews (Apic. 2.1.5, 4.2.17). Had tongues and brains been commonly consumed as gourmet items in Roman Italy, I would have expected Apicius to list more recipes for them.

[109] There are a number of examples, but principally from Britain: Walmgate, York (O'Connor 1984); St. Peter's Street, Northampton (Harman 1979); Knapp Drewett (Serjeantson et al. 1987); Rudson Roman Villa (Chaplin and Barnetson 1980); Rye (Kyllo 1981).

Neatsfoot oil is a fine, thin oil which is excellent for treating and currying leather. It is produced by boiling the phalanx and metapodial bones and skimming the oil (Thorpe 1922; Serjeantson 1989).

Little is known about the tanning trade in Roman antiquity.[110] Although several references to tanning materials are noted in the texts,[111] the Roman writers make sparse comment about the processes involved in tanning hides, presumably because they were inexperienced with these (Reed 1972: 90) as tanning was likely a lower-class activity. The ancient authors are not specific about the state in which skins arrived to the tanner; however, from the zooarchaeological evidence it appears that some skins were delivered to tanneries with the feet still attached, possibly so that neatsfoot oil could be extracted from the phalanx and metapodial bones.

Horn cores are another skeletal element which might relate to the tanning trade. Serjeantson (1989: 136) notes that aside from the feet, sometimes the cattle head remained attached to the hide sent to the tanner. Horn was a valued commodity (MacGregor 1985, 1989) so it is unlikely that horn cores were discarded without removing the horny sheath. Any horns still attached to the hides received by tanners were probably removed and passed on to horn workers, an exchange facilitated by the fact that both usually worked near each other in the part of town devoted to the smellier craft industries (Serjeantson 1989: 139).

Although many Roman period sites in Italy register sawn and chopped cattle (and sheep/goat) horn cores, it is difficult to decipher what percentage of this is due to butchery and hide removal, or is associated with horn working. The key lies in the quantity of sawn horn cores and their placement. The occasional find of relatively few sawn cattle or sheep/goat horn cores suggests nothing more than small-scale handicraft. The deliberate removal of many sawn horn cores, such as at Carminiello, suggests practice of hide removal (i.e., horns leaving the site while still within the hide). The massive deposit of 601 cattle horn cores from Aquileia probably relates to a horner's workshop.

A further complication in interpreting animal bone deposits from urban contexts relates to the worked-bone industry. As noted earlier, the best raw materials for bone-working are the cattle metapodials. The central shaft of these bones is long, fairly flat, and relatively thick. Moreover, the metapodial bones are associated with both little and poor-quality meat, and are often considered waste in carcass butchery. An excess of cattle extremity bones (including the metapodials), therefore, may relate to bone-working activities. These could have been saved for future bone-working, but might also just be waste from carcass butchery or hide preparation. Without more evidence, it is difficult to judge. The case for bone-working is strengthened if partially worked-bone wedges, bars, rods, rings, or other preliminary shapes, generally referred to as blanks (Reese and Hutchinson 1988: 558) accompany these metapodials. In this manner, the connection between unworked raw material and finished product is more secure.

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[110] Reed (1972: 92) comments that "although the writings of Greece and Rome provide us with little knowledge (about tanning), a more plentiful source of information is available (in) what is loosely called the rabbinic literature of the Jews, whose unique value as a guide to ancient technological practice has not been fully recognized."

[111] Pliny (*NH* 24.91) notes that the dried leaves from the "rhus" plant as well as pomegranate rind are used in tanning leather. Later he states that the plant "notia" is well-known under various names in tanning shops (Plin. *NH* 27.175).

The recovery of the odd bone blank at sites such as Monte Gelato and Pozzuolo del Friuli, even where accompanied by the occasional metapodial or other long-bone waste fragment, is of little consequence. If these finds are indicative of the scale of bone-working at the site then it seems that operations never advanced beyond a simple handicraft level. Indeed, on the basis of available faunal evidence it appears that none of the rural or urban2 sites listed in this report had any sort of bone-working industry. If bones were even worked at these sites, this was performed on a hobby/handicraft level.[112] Of all the Roman period sites in Italy only Pompeii 94 contained more than a few blanks or waste fragments, in addition to unworked cattle metapodials and other raw materials. Certainly, some bone working occurred at this site, but available evidence suggests that it was still conducted on a relatively small scale. Perhaps the largest collection of both worked-bone artifacts and waste materials in Italy comes from recent excavations of a late fourth century AD *domus* on the Palatine Hill in Rome (St. Clair 1994). The faunal materials from this site are currently being analyzed (David Reese, personal communication), but evidence of the hundreds of worked-bone artifacts in conjunction with the massive number of blanks and precursor materials is indicative of a productive industry in this urban context. The organization of the Roman bone-working industry in Italy and the rest of empire requires further research, but this topic is outside the scope of this thesis.[113]

In contrast to urban1 sites, the averaged pattern for cattle parts amongst both rural and urban2 sites shows less of a discrepancy between values (see Table 59). This indicates that relatively more whole animals were slaughtered, and subsequently consumed and disposed of at these sites than at urban1 sites. Some extra primary cuts appear to have been imported to urban2 sites, but in relatively fewer quantities than those received by urban1 sites according to the zooarchaeological data from Table 59. On the basis of the inflated value for cattle extremities at rural sites it seems that either these lower leg bones were selectively imported (perhaps in a hide), or that a small proportion of primary and secondary beef cuts were exported. Both of these explanations are plausible. The latter one best explains the dearth of primary and secondary cuts of beef at the rural site of San Giovanni in particular. As for the former explanation, it is possible that some rural sites operated as tanneries, in which case cattle hides with the lower parts of the legs may have been imported for processing, with these bones subsequently discarded with the tanning waste. Whittaker (1983: 175) argues that "rural estates had always controlled much of the specialist manufacture," citing legislation in the Theodosian Code (13 19.1-3 [AD 400]) attempting to prevent *collegiati* and *ministeria* from leaving towns as supportive evidence. In the absence of specific information about ancient tanneries, however, it is impossible to judge the scale of operations at rural, suburban, or urban centres. Rural sites may have fulfilled important roles as tanneries, but certainly such industries also existed in or very near urban centres.[114] Animals were herded into towns for slaughter and butchery. Considering the urban demand for leather goods[115] it seems silly to export the hides from these animals to rural sites only to later import the processed and tanned product back to the city. Perhaps suburban areas played an important role. If major slaughterhouses were located outside the city, as Frayn (1993: 109) suggests and as I discuss further in Chapter 11, then it seems logical to place the tannery nearby to limit the distance the hide and connected bones (i.e., the butcher's by-products) had to be moved for subsequent processing. Moreover, considering the stench associated with tanneries -- no doubt a factor of handling dead animal skins and using pungent materials such as urine and dung during processing -- it seems necessary to locate them away from residential sections of town. According to the rabbinic texts, a tannery must be at least 20 m outside the town, and down wind from it (Reed 1972: 95).[116]

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[112] MacGregor (1989:110) comments that for the 8th - 11th centuries in northern Europe "the bulk of the (articles made of bone) clearly involved no significant level of craftsmanship and were evidently made by individuals as required." A similar situation may apply to Roman Italy.

[113] Stephen Greep (1983) addressed some of these issues, but generally as they relate to Britain, in his Ph.D. thesis *Objects of Antler, Bone, and Ivory from Roman Britain*. On the topic that different types or levels of production exist he informs me that "there is clear evidence from Britain that this is so, with some well organised production occurring in towns (occasionally it is possible to plot distribution of forms) but with more ad hoc organisation in rural sites" (Stephen Greep, personal communication). The craftsmanship involved in the manufacture of some objects, such as composite combs and some ivory pieces, is quite high and would imply some craft organization. A guild of ivory carvers is recorded in Italy (Greep 1983, cf. Waltzing 1895-1900). However, Greep adds that the topic is complex especially when you consider that "...workers may be utilising more than one type of material" (e.g., metal, wood, and perhaps jewels, as well as bone), and "...that even town production sites may represent the efforts of 'itinerant' workers rather than established 'factories'" (Stephen Greep, personal communication).

While the averaged patterns for cattle parts imply some movement of skeletal parts between rural, urban1, and urban2 sites, it must be remembered that there is great variability within each site type and a number of exceptional sites which do not conform to these typical patterns. Amongst the rural sites, Monte Barro has more bones from the cattle head and less from the extremities than expected, while the site of Gravina shows the reverse pattern. A suggestion is that relatively more cattle hides, which included the lower foot bones, were moved out of Monte Barro, presumably for tanning at some urban or suburban locale. There is insufficient data to determine where exactly these hides may have gone, if indeed this was the case. The urban1 site of Populonia claims more cattle extremities and fewer heads than expected, so it is possible that some hides from rural sites were moved to urban areas. Alternatively, the pattern at Monte Barro might simply be the result of differential disposal and recovery. Perhaps the bulk of the extremity bones was discarded elsewhere in unexcavated sections of the site.

The cattle parts pattern at Gravina is also atypical of rural sites in general in registering fewer bones from the head and more extremities. It appears that some cattle hides or at least extremity bones were imported to the site. Excavations at Gravina unearthed a number of worked bone artifacts and precursor pieces, including sawn cattle metapodials. It is possible that extremity bones were brought to the site as raw material for handicraft purposes. Alternatively, cattle hides which did not contain the head or horns, but still had the extremity bones intact, could have been imported to the site for leather processing. Relatively more extremity bones would then be discarded at the site consequently biasing the faunal counts in their favour.

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[114] Serjeantson (1989: 137) argues for an urban location of tanneries in Roman and Medieval sites in Britain. At Pompeii, fifteen large masonry vats and several oblong basins lined with wood, presumably all used for tanning, are identified in a building (Regio I.5.2) which is at the southern edge of the city near the Stabian gate (Frank 1933-40, vol. 5: 260-261; Faber 1948: 647). Currier's workshops are noted in Pliny (*NH* 24.175) but a location is not specified.

[115] The Edict of Diocletian (8.6-41) lists prices for tanned and untanned hides from a number of animals, including cattle, goat, sheep, deer, gazelle, wolf, badger, beaver, lynx, seal, and lion. Subsequent sections deal with costs for a variety of leather goods (*Ed. Diocl.* 9.1, 10.1)

[116] Similar conditions apply today. Tanneries in London have for many centuries been located in the southeast region of the city (Reed 1972: 95), while those in Marrakech, Morocco, are situated at the eastern edge of the city, against the walls, and near the river (Jemma 1972). Jemma (1972: 15) comments that most tanneries are at the city walls.

Several urban2 sites—notably Otranto, Stufels, and Innichen—contained an above average frequency of bones from cattle heads, compared to other urban2 sites. Others, such as Pozzuolo del Friuli and Invillino, reported fewer heads but increased values for bones associated with primary and/or secondary cuts of beef. Several explanations, from movement of parts to differential disposal, to consumption of better quality cuts at Pozzuolo del Friuli and Invillino in relation to increased wealth at these sites, might all be used to explain this pattern. However, a definite answer cannot be determined on the basis of available data.

Zooarchaeological data for sheep/goat parts indicate that some whole animals were killed amongst all site types, but they also attest to differential disposal or import/export of skeletal parts. Rural sites, on average, have slightly fewer extremity bones than might be expected had only whole sheep and goats been discarded. It is possible that some of these had been removed from the site within the hide, possibly to urban1 or urban2 sites, both of which record fairly high mean values for sheep/goat extremity bones. Three rural sites—San Giovanni-period 3, Settefinestre-period2, and San Giacomo—had even fewer sheep/goat extremity bones, and inflated values for heads than the average rural pattern. Since this pattern cannot be explained by recovery bias—excavators were careful to retrieve all faunal material at each of these sites; screens were used at San Giovanni—the impression is that sheep/goat bones from these sites in particular represent initial slaughter and butchery waste, with export of hides. Moreover, low values for primary, and to some degree secondary cuts at San Giovanni-period 3 and San Giacomo especially, attest to some export of this better quality meat.

If primary cuts are being exported from some sites then it follows that others will be importing these bones. Urban1 sites seem the best candidates for import of better-quality sheep/goat meat, a hypothesis supported by the fact that, on average, they yield the highest frequency of primary cuts amongst all site types. Some urban1 sites such as Schola Praeconum, Populonia, and Luni fit this pattern, and in doing so hint at a more elite diet. Other urban1 sites like Modena contain more extremity bones and fewer primary and secondary cuts than expected, which may be indicative of a less-privileged diet, or relate to hide processing activities. Still other urban1 sites such as Pompeii-Ganimede and Naples-Girolamini register more bones from sheep/goat heads, perhaps because the deposits here contain more waste from earlier stages in animal slaughter and butchery, rather than materials discarded as cuts are prepared for cooking and final consumption. Alternatively, these heads may have been consumed, but whether or not as a gourmet item is difficult to determine in the absence of more detailed contextual information for these two faunal samples. While sheep's head is often considered a delicacy in Greek and Eastern

Mediterranean cultures, this does not seem to apply to Roman Italy. Juvenal (3.293-294) makes reference to boiled sheep heads as part of a Jewish cobbler's meal. From the context we can infer that sheep heads were principally consumed by Eastern peoples and may not have been luxury foods for Romans, considering they formed part of a relatively poor cobbler's meal. Apicius lists no recipes for sheep or goat head in his cookbook.

While the overall high value of extremity bones amongst urban2 sites might be related to an import of sheep and goat hides, such a pattern might also be due to an export or differential deposition of caprine heads, and primary and secondary cuts. The relatively low value for primary cuts at urban2 sites suggests that at least some of these cuts were moved elsewhere, possibly to urban1 sites. There is much individual variation amongst urban2 sites, however, which is de-emphasized when comparing mean values. The reasons behind the various patterns are not always known, nor can they be determined on the basis of available data. Some sites such as Stufels-Senoner and Innichen record fewer heads and feet but more primary and/or secondary cuts of meat. This might indicate that the bone waste derives from later stages of butchery and consumption, but could also be related to import of better-quality cuts of meat. Other urban2 sites such as Colognola, Stufels-Hotel, and Invillino contain more bones from sheep/goat heads and less from the better cuts of meat, perhaps indicative of initial slaughter and butchery waste than cooking and consumption refuse. Cozzo Presepe is unique amongst urban2 sites in having fewer bones from the head and primary cut areas of sheep/goat but more associated with secondary cuts and limb extremities. Such a pattern suggests a lower class diet. Presumably the bulk of the sheep/goat heads were deposited elsewhere at this site, while primary cuts may have been exported, thus leaving the lower parts of the leg for local consumption.

As in the case with cattle, caprine feet usually remain in the hide after it has been stripped off the animal, and are subsequently disposed of with the tanning and hide processing waste. While the excess of sheep/goat extremity bones amongst urban2 sites hints at a preference for caprine hide processing at Roman settlements as opposed to rural or urban1 sites, there are exceptional cases. The relative lack of extremity bones from urban2 sites such as Colognola and Invillino implies insignificant hide processing activities, while their preponderance at the sites like Cozzo Presepe and Stufels-Senoner points towards a greater degree of tanning. However, the data suggest that other types of sites processed sheep/goat hides. Above average numbers of sheep/goat extremity bones at Modena, an urban1 site, might be attributed to sheep/goat hide processing, while a similar explanation might explain the inflated values for sheep/goat lower limb bones at rural sites such as Gravina, Settefinestre-period 3, and Via Gabina.

The Romans consumed practically every part of the pig, and rated certain cuts and joints as better-quality. The presence of bones from nearly every part of the pig skeleton at most sites indicates that at least some whole animals were slaughtered and consumed, but the fact that standardized frequency ratios are never equal at any given site indicates that some skeletal parts received different treatment, be it disposal elsewhere at the site or transport out of the area. The zooarchaeological data confirm the existence of differential deposition and/or import/export of pig skeletal parts, but the pattern varies amongst site types. Rural sites, on average, record an excess of bones from the pig head, which suggests that the rest of the carcass was moved elsewhere, leaving behind the head as part of the initial slaughter waste. It is possible that many pigs were slaughtered at rural sites, with some cuts of meat, including the trotters exported to other sites. Alternatively, these cuts may have been disposed of somewhere else at the rural site. In any event, the excess of bones from the head of the pig amongst rural sites in general suggests some differential treatment of parts of the carcass. Moreover, the pattern hints at some separation of slaughter and initial processing waste from that produced during latter stages of butchery, cooking and consumption. It seems that not all animal bone garbage was necessarily dumped in the same spot at any given site.

Mean values for pig parts at urban2 sites indicate that whole pigs were slaughtered and consumed on site; the minimal divergence between values suggests that overall urban2 sites contained the greatest percentage of whole carcasses. Nevertheless, the slightly inflated figure for primary cuts over other skeletal parts suggests some import of better-quality pig meat from the shoulder and rear.

Although some pigs were slaughtered at urban1 sites on the basis of the recovery of bones from all parts of the skeleton, these sites in particular show a great discrepancy between the various pig part categories. The data imply substantial import of cuts, especially primary cuts. These register nearly twice that of pig extremities, suggesting that for every whole pig killed at an urban1 site, the bones associated with the primary cuts of another pig had been brought into the city. This pattern is quite marked at several urban1 sites—Pompeii-Ganimede, Luni, Populonia, Modena—all of which have more bones from primary and/or secondary cuts than the average urban1 site, which itself shows an excess of primary cuts. Alternatively, pig bone waste from Altino and Naples-Santa Patrizia is characterized by fewer primary and secondary cuts and more enhanced levels for heads and extremities. The impression here is that relatively more whole pigs were slaughtered, consumed, and disposed of at these two sites, with minimal import or export of pork cuts.

While the mean values for pig parts at the various site types suggest some movement of carcass parts, specifically export of primary cuts from rural sites and their subsequent import to urban1 sites, there are a number of individual sites which do not conform to these averaged patterns. For example, the sites of Matrice, Via Gabina-site 10, and Monte Barro register slightly fewer bones from the pig's head and/or feet, but an increased frequency of primary and secondary cuts compared to other rural sites. The impression is that these sites did not export many pig cuts, but rather retained and consumed most (all?) parts of the pig carcass on site. At the opposite end, other rural sites such as San Giovanni-period 3 and Settefinestre-period 2, and to some extent Gravina, record an excess of pigs heads but very few bones associated with primary and/or secondary cuts. Such data uphold the general notion that rural sites exported better-quality cuts of pork.

Several urban2 sites also stray from the averaged pattern, which shows slaughter, consumption, and disposal of fairly whole pigs, but with some import of primary cuts. There are a number of combinations. Invillino records more bones from primary and/or secondary cuts of pork, but fewer extremities and/or heads than average. This pattern suggests a wealthier diet and is more prominent amongst urban1 sites. Colognola and

Stufels-Hotel register more bones from pig heads than expected, a pattern associated with slaughter discard as opposed to waste from the later stages of butchery and consumption. Finally, Stufels-Senoner contains a smaller frequency of bones from the pig head but more from the extremities. Such a pattern could arise if some carcasses were imported without the head, and further prepared at the site. Some extremities may have been removed from these carcasses and disposed of, with better cuts of meat moved elsewhere.

While the zooarchaeological data for cattle, sheep/goat, and pig parts may indicate differential deposition and import/export of skeletal parts, in many cases we can only speculate about the exact cause or causes of these patterns. Moreover, we cannot always be sure which mechanism is acting and to what degree. For example, an import of primary and secondary cuts to a site will reveal itself in the zooarchaeological record in the same manner that an export of heads and extremities will. The net result, after taking into account taphonomic biases, will be an imbalance in the ratios with primary and secondary cuts outnumbering head and extremities. Although zooarchaeological patterning allows us to pinpoint when something is askew in terms of skeletal part representation, there are often a number of possible explanations for each scenario.

There are insufficient zooarchaeological data to determine if young animals were consumed whole, as would seem to be the trend on the basis of textual references. Although this can be deduced by tabulating skeletal part frequencies by age group (taking into account varying taphonomic and recovery biases), most zooarchaeological reports did not present the data in this manner. Age data were normally given separate from skeletal parts listings. Whole young pigs and/or lambs are noted at some sites—Vaste, San Omobono—but the "special" nature of these deposits sheds doubt on their value in normal dietary reconstructions. These animals could have formed part of some ritual sacrifice in which case a whole animal would have been necessary.

Interpreting animal bone deposits from urban sites is difficult. On the one hand is the expectation that whole animals or nearly complete carcasses were imported. The faunal evidence shows that this was doubtless the case. The remains of all parts of the cattle, sheep/goat, and pig skeleton have been recovered from practically every urban site listed in this report. Clark (1992a: 61) states that animals destined to be sold on the open market in late Medieval Italy "had to be brought to town on the hoof and examined by the appointed officials whilst still alive." Furthermore, she notes examples of early 15th century legislation from Italy which required butchers to display the animal's head so that customers could distinguish the age and species of the carcasses being sold (Clark 1992a: 61). Similar practices may have been implemented during Roman times judging by the inclusion of the remains of animal heads, generally a waste product, in urban1 deposits. It would certainly be easier to obtain the head from an animal slaughtered near or at the butcher's shop than to import it along with carcass parts over any great distance. Whether or not Roman meat inspectors existed, however, is a different story which cannot be confirmed from available textual evidence. Sellers were told to be honest in their sales (Cic. *Off.* 3.12-13,14,16) and systems for weighing were in place, at least during some periods (*CIL* 6.1770-1; *CTh* 14.4.2; Sirks 1991), but this certainly did not stop deceit.

While some live animals were surely brought to the market for sale and butchery, it is unlikely that many large animals such as cattle were sold live in urban areas, unless of course they were purchased as working beasts and not for immediate slaughter and consumption. One cow yields around 200 kg of meat. Thus, I doubt a single family purchased a live cow from the market which they subsequently butchered solely for themselves. They certainly could not consume all this meat before it went bad, and 200 kg of beef is a considerable amount for one family to preserve. It seems more likely, therefore, that if whole cattle were purchased as meat animals for eating that this formed part of some larger feast, such as a religious sacrifice, where there would be many to feed, or was a joint venture amongst a number of urban consumers, who could subsequently divide the carcass into smaller sections for their personal use.

Some of the smaller animals such as sheep, goats, and pigs might be sold live, and subsequently butchered and consumed by households. However, each of these animals still produces a considerable amount of meat for one family to consume (e.g., even a small sheep yields over 20 kg of meat), and it seems more probable that any such purchases were intended for special feast occasions or sacrifices where they would be many to feed, or were done by a group of families intending to share the meat.

If whole animals were not purchased for consumption in urban centres, then the only other viable option for many would be to purchase cuts of meat. Both the zooarchaeological and textual data confirm that this did occur, as the above discussion on skeletal parts indicates.

Meat Diet and Social Class

It is difficult to examine class differences in meat diets from zooarchaeological remains for two basic reasons. First, the archaeological record of Roman Italy is biased in favour of the more elaborate structures presumably occupied by wealthier people. We have limited excavation evidence for small huts and peasant dwellings, and no zooarchaeological data from such projects. It is possible that poorer individuals disposed of their rubbish in abandoned buildings once occupied by the elite, but in the absence of clear contextual information it is difficult to separate these activities. Moreover, class differences in meat consumption would be impossible to distinguish in a dump used by both poor and upper class people. Although slave or workers' quarters have been identified at a number of Roman villa sites, only Settefinestre and Gravina reported disposal differences in the zooarchaeological waste which may have set apart the meat diet of these slaves from the more elite occupants of the villa. Bones from older cattle and those associated with fairly tough cuts of meat predominated in the slave lodgings excavated at Settefinestre, while wealthier sections of that villa contained more remains from younger animals, especially pigs (King 1985: 284). One pit, F202, from inside the villa at Gravina contained an abundance of lamb and wild animal bones, suggestive of a wealthier diet (MacKinnon 1994). Faunal remains found in the courtyard around the probable slave quarters at the site show a much different pattern with very poor representation of wild animal and many more bones from older sheep/goats and cattle (MacKinnon, in progress).

A second complication of inferring class differences in meat consumption from zooarchaeological data is that the animal bones yield no evidence about how the meat dish may have been displayed. As noted earlier, spices, sauces, and an ostentatious presentation can otherwise turn a fairly bland dish using a poorer cut of meat into an extravagant dish, and we know from the ancient texts that this was practiced.

The anthropologist Marvin Harris' (1985: 24) statement that "within most societies, developed as well as under-developed—the higher the income bracket, the greater the proportion of animal products in the diet" appears to hold true for Roman Italy. The zooarchaeological data show that meat was certainly consumed among the upper classes in Roman Italy in both urban and rural locales. In fact, "meat was considered central to civilized life" (Wilkins 1996b: 172). Urban elite seemed to have consumed more better-quality cuts of meat judging by the predominance of bones associated with primary cuts at these sites. Rural elite, however, added extravagance to their diet by incorporating more wild game, which confirms Martial's (4.66) comment. Columella's (7.2.1) suggestion that lamb and mutton were more popularly consumed in the city finds some support when examining zooarchaeological data from Imperial period rural and urban sites in central Italy, but not during other time periods in this region. There are insufficient data to investigate this trend for other geographic areas and temporal periods.

Although some Roman elites insisted on dietary opulence, this was probably not a daily luxury for most, even if they could afford it. On the basis of Martial's, Juvenal's, and Horace's critical comments denouncing extravagance, even among the rich, we might conclude that many elite preferred a simple diet like that of ordinary people (McLeish 1978: 43). It is difficult to judge how commonly meat was consumed amongst the rich, but I doubt it was eaten daily at both lunch (*prandium*) and dinner (*cena*). Rixson (1989: 58) states that the less palatable products of the animal, such as the stomach and intestines, are usually discarded when there is an abundance of meat. The fact that Apicius provides recipes requiring these two products suggests that meat was not as plentiful during Roman times as it may be in Italy today. However, this hypothesis hinges on the assumption that stomachs and intestines were chiefly viewed as waste products. It is also possible that these parts were popular in the Roman diet, but this is impossible to tell from the zooarchaeological data since neither organ is directly associated with a skeletal part.

In light of the few references in the ancient texts alluding to peasant meals, it seems logical to assume that the Roman poor ate less meat than their elite counterparts, even if this cannot be verified using zooarchaeological data. The resources available to the rural and urban poor likely varied, but meat probably formed an insignificant part of the diet for each group. The expense and availability of meat were certainly limiting factors for any Roman peasant regardless of his habitat. As Frayn (1975) argues, rural peasants operating a subsistence-level farm probably relied on staple cereal foods and supplemented this with foodstuffs which could be gathered and added to the diet at no extra cost. I suspect rural peasants ate some meat, if only on an occasional basis, and predominantly cheaper and tougher cuts of beef, although there are insufficient zooarchaeological data to test this hypothesis. They may also have hunted small wild birds, mammals, and fish as a supplement, but larger game, like larger fish were reserved for the rich, who wrote various treatises on the skills of hunting (Wilkins 1996a: 104).

It is difficult to speculate on the amount of hunted wild meat which may have supplemented a rural Roman Italian peasant's diet, since this depends on many factors, especially the availability of staple food resources such as grain. It seems probable that peasants spent more time hunting small game during periods when crop yields were low; however, this would have to be balanced against the labour costs involved. Johnson (1980: 26) provides labour cost figures of 1,151 kilocalories/kg for hunting and gathering versus only 80 for gardening. Furthermore, the frequency of failure in hunting would be high. Gallant (1991: 120) concluded that hunting could play an important but only secondary role as a means of supplementing the diet and producing some high protein meat during times of crises in ancient Greece. A similar case likely applies to Roman Italy.

Shepherds, like rural peasant farmers, were generally viewed as lower class people (Mart. 7.80), but considering their occupation it is probable that mutton and goat meat was more important to those peasants involved in pastoral economies than to the majority of sedentary farmers simply because few other animals would be available to them. Ill, feeble, and unproductive elderly members of the flock, which could otherwise not be sold or traded, would have to be consumed by the shepherd to avoid waste. This might be supplemented with meat obtained from wild animals killed for the protection of the flock.

Urban poor doubtless had fewer food options available to them than their rural counterparts. Most could not forage for wild resources in the countryside,[117] and few probably had the space to tend a garden, let alone keep any livestock. Moreover, their kitchens and cooking facilities were limited compared to those of the elite. Commoners in humble urban apartment dwelling probably had only a portable charcoal brazier with which to cook meals (Hermansen 1974: 173). The majority of urban poor were likely forced to purchase their foodstuffs from markets, butchers, and other food suppliers. The expense alone certainly limited the amount of meat a Roman urban peasant could afford to buy at normal butcher shops; no doubt, most of that consumed came from public sacrifices. Meat left over from animal sacrifices could be obtained at *popinae*, or specialized butcher shops/taverns which distributed such meat. Apparently these places had a bad reputations; therefore it is unlikely that anyone of status would have visited them (Tanzer 1939: 41). The butcher at these shops assisted the priest at sacrifices where animals were offered, and thus was allowed to sell the remains after the conclusion of the ceremonies. Wilkins (1996a: 104) adds that

> we should still think of peasants in [ancient Italy and Greece] as eating meat only on special occasions. That is meat from domesticated animals. Meat from wild animals fish, and birds was not classified as sacrificial; thus small birds, hare, and fish often appear as tasty additions to the bland peasant diet.

Although wild animals might have been available for consumption in Roman cities, I suspect that many urban poor could not afford to purchase them. Moreover, most probably lacked the resources and time needed to hunt such game, assuming they had access to forested regions or game preserves, presumably a rarity.

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[117] Most of the suburban land around major cities like Rome was privately owned and presumably unavailable to any urban peasant foragers (Cherry 1993: 438).

In addition to sacrificial allotments, urban peasants may also have received meat from government or private citizen distribution schemes, but these were somewhat inconsistent. They may also have purchased cheap beef and pork sausages (but probably not the more expensive Lucanian sausages) from butchers and sausage sellers. Dohm (1964: 31-35) notes that sausage sellers were the lowest form of cook in the Roman world. As such they probably catered chiefly to a poorer clientele.

Meat in the Military Diet

None of the sites used in this thesis are specifically military sites, so there are currently no zooarchaeological data to help reconstruct dietary patterns for troops stationed in Italy. Far more information exists about the military diet in the Roman northwestern provinces, especially Britain (King 1984), where many military sites have been excavated.

Meat certainly formed part of the military diet (André 1981: 145-146; Corbier 1989: 229-230; Davies 1971). The tablets from Vindolanda (Chesterholm) confirm the distribution of pigs and wild animals to the soldiers of this garrison in Roman Britain (Bowman and Thomas 1983: 47, 93-96). According to another reference from sixth century Egypt, the smallest daily ration of food per solider includes 1 lb or about 0.45 kg of meat (*P Oxy*. 2013-14). Goldsworthy (1996: 292) states that if this is correct, then a legion of 5000 men would consume 12.5 cattle, 120 sheep, or 38 pigs per day. While a portion of this could have been supplied in preserved form, I suspect that fresh meat was preferred where it could be obtained. "Most armies drove large herd of animals with them on the march, often captured from the enemy, confiscated from the native population, or supplied by allies" (Goldsworthy 1996: 292). Animals were raised on military lands which extended for a considerable distance around each fort (Davies 1971: 123). Of the three principal domesticates, cattle seem to be the animal of choice for most Roman armies in northern Europe (King 1984). They did not require extensive maintenance, produced an abundant amount of meat, and could be easily herded if the army was mobile.

It is difficult to determine the role Italy played in providing for the army, or how this may have changed over time. The texts recognize that regions of the Roman empire did supply meat to armies, much of which was in the form of salted pork (*CTh* 7.4.2 [AD 355]). There is no specific mention of Italy, or any other region for that matter, but it seems likely at least some part of Italy was taxed or otherwise coerced into providing for the army at some point in time. Owing to transport difficulties, however, it is unlikely that preserved meat was supplied by the Roman Italians to any garrison other than those stationed proximal to the country. North Africa, to the south, and the Alps to the north, might have been the furthest regions provisioned with Italian meat. These distances may have increased during stressful periods, such as episodes of war, when preserved meat was likely consumed more often for food, and *laridum*, or fat, was needed as an alternate fuel (Davies 1971: 124).

The zooarchaeological data generally report relatively low values for primary and secondary cuts of pork and mutton at Roman rural and settlement sites in Italy, compared to urbanl sites. I have argued above that some of these better-quality cuts were probably imported into cities; however, it is also possible that some were preserved and sent to feed the army.

Until more faunal data become available from military sites in Italy and neighbouring areas, it is impossible to determine the role the country played in provisioning the army. However, even then there are complications. The texts disclose that armies could not always rely on food rations and were encouraged to seek alternate methods to obtain meat. Thus, we might expect to find the remains of local species of animals amongst the waste deposited at military sites, in addition to waste from meat supplied by exterior means. The latter might not even leave potentially traceable bone remains if it had been imported as salted and deboned strips or cuts of meat.

Organized systems of provisioning meat to the army do not appear, or at least are not referenced in the texts, until the Imperial period.[118] A second wave of references dates to late antiquity (e.g., Theodosian Code). Whether or not this is due to effective government organization or increased military activity during these later periods remains unknown. Presumably both factors contributed. Wars, however, certainly occurred within and outside of Italy before the Imperial period. In the absence of army food rations, did troops simply raid local farms and strip resources from the land, or were other supply mechanisms in place? These questions remain unresolved.

Finally, in addition to meat provisions, armies also required horses for the cavalry and various beasts for transport purposes, of which cattle certainly formed a part. Again in the absence of zooarchaeological data from military sites in Italy, it is difficult to determine the role of cattle in this respect. I suspect that most were purchased or confiscated from civilians in the warring regions, and not transported from Italy, especially if this entailed long distances. Davies (1969, 1989), Goldsworthy (1996) and Hyland (1990) provide greater discussion about cavalry and work animals (principally mules, asses, and pack-horses) in the Roman army.

Sumptuary Legislation

The need for sumptuary legislation confirms the existence of dietary extravagance in Roman Italy during at least the late Republican/early Imperial periods, but it is difficult to tell from the animal bones if the implementation of sumptuary legislation had any impact on the amount of meat consumed in Roman Italy. From the textual record we know that most of these laws were passed during Republican times, from c. 2nd century BC until about the turn of the millennium. By Tiberius' reign they had fallen into disrepute (Tac. *Ann.* 3.52-55). It not known how strictly these sumptuary laws were enforced, but transgressors certainly existed throughout their implementation. These laws were mainly concerned with the prices in *macella* (i.e., the typical Roman alimentary markets) and in shops administered by or through the *aediles* (Frayn 1993: 127), and thus really only affected purchased meat. They were likely ineffectual with wealthy people who presumably had access to food supplies on either their own land or from family and friends who never came to market. Considering this problem, it is perhaps better to examine the effects sumptuary legislation may have had on the Roman meat consumption by looking for changes in urban1 diets, especially between Republican and Imperial times. Compared to a rural site, an urban site would presumably be more closely linked to a market, at least in terms of actual purchases. A rural site might play a role in supplying this market with meat, in which case sumptuary laws could have an effect on animal husbandry schemes, but the actual consumption at the rural site itself would be less likely to be affected by such legislation. Instead, diets at rural sites were probably more influenced by factors such as the occupants' culinary tastes, species' availability, and the amount of disposable wealth, rather than being dictated by sumptuary legislation. Zooarchaeological evidence shows a decline in the proportion of wild animals in the average urban1 diet moving from the Republican period to the Imperial Age. This pattern is consistent amongst urban2 sites as well, in both central and northern Italy. There are insufficient data for urban sites in southern Italy. The drop in wild resources is contrary to what we might expect had there been caps placed on food expenses. If wild meat was more expensive than domestic meat in Republican times (as was the case in Late Antiquity according to prices in the Edict of Diocletian) then we might expect less of it to be purchased especially if sumptuary legislation was effective at limiting food expenses during this period. The zooarchaeological data do show a decline in wild meat during Imperial times, which may in part be a delayed reaction to sumptuary legislation. However, by this time the laws were not enforced. It seems that legislation only encouraged people to spend more on food resources, including more expensive wild meats, during Republican times. Ironically, not enforcing these laws seems to have achieved their original intent in curbing spending.

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[118] Although prior to this time trade in other commodities, such as wine and pottery for the army certainly existed and is outlined elsewhere (see Middleton 1983; Tchernia 1983). Middleton (1983) argues for a link between those bulk supplies transported over long distances for the army and those destined for civilian trade.

The zooarchaeological data for domestic mammals further suggest that the sumptuary laws were ineffective. Republican period sites register more bones associated with the better-quality primary cuts of beef and pork than do their Imperial period counterparts. This is contrary to what might be expected had legislation prohibiting the purchase of these presumably more expensive cuts of meat been upheld. However, the zooarchaeological data do not inform us about the relative amount of meat consumed during any time period. It is possible that far less was spent on meat during earlier periods when the sumptuary legislation was in effect, with people choosing to purchase and consume better-quality cuts on an infrequent basis, rather than acquiring a greater quantity of the cheaper cuts on a more regular basis. The aggregate demand from selective consumption of one pork shoulder per week per person rather than ten trotters (assuming for example sake that the price of one shoulder equals that of ten trotters) would still produce an over-representation of primary cuts in the zooarchaeological data, even if the consumer abided faithfully to sumptuary legislation limiting his meat expenses.

Chapter 8

DISCUSSION:
TESTING THE MODELED CRITERIA FOR CONSUMPTION

Each criterion from the modeled characteristics of consumption sites is discussed below.

(1) A predominance of animals of prime meat ages, usually younger animals

Although sample sizes are small, the data for cattle generally conform to this criterion of consumption sites. Rural sites, on average, contain a greater proportion of older cattle than either urban1 or urban2 sites. As such, the bone remains from rural sites seem less geared towards strictly consumption than those at urban sites. I interpret this to mean that most cattle at rural sites were first used as working beasts before being consumed when they had reached old age and were no longer efficient at pulling the plough or drawing carts and wagons. Urban1 sites register the largest frequency of younger calves, which supports the hypothesis that they were active in consumption.

Sheep/goat data are less distinct than those of cattle in terms of recognizing a preponderance of animals of prime meat ages between site types. The fusion and dental data do not always agree, but it seems that more than half of the sheep/goats were killed between 12 and 48 months, regardless of site type. The dental data for urban1 sites show a peak in deaths at 7-12 months and another at 36-48+ months, which might correspond to import of lambs/kids less than a year old as well as mature animals which had reached their maximum weight in the third/fourth year. This pattern suggests a fairly regular meat-marketing system in urban1 locales with a two tiered distribution of age groups imported. A similar strategy seems to have been in place at urban2 sites, but here most sheep/goats were killed between 24-36 months of age. Individuals at this age would have also reached their maximum weight and, if not exploited for wool or milk would be best slaughtered for meat since any more feeding would be counterproductive since it would not increase the amount of meat per animal.

According to both the fusion and dental data, rural sites appear to have consumed the greatest relative frequency of younger sheep/goats compared to other site types. Dental statistics show that, on average, about 30% of the sheep/goats were slaughtered in their first year and presumably consumed at rural sites, with another 30% killed in the age bracket 12-24 months. This pattern is contrary to what might be expected for production of caprines, where many more older individuals should be present, but it does accord with the consumption criterion above. Perhaps rural occupants could choose to eat relatively more young lambs and kids as part of their diet simply because more animals were available to them from the flocks they raised. Presumably these younger individuals were chosen in a manner which did not adversely affect herd propagation. If the flock numbers needed to be trimmed, and it was not advantageous or economical to send younger caprines to urban markets, then what better way for a rural producer to deal with excess lambs and kids but to eat them himself.

The situation with pigs is also difficult to interpret. Urban sites do not show a preponderance of young pigs. In fact many of them, especially the larger urban1 sites, seem to have consumed more older pigs than did their rural counterparts. Dental and fusion evidence suggest that most of the pigs consumed in Roman cities died between 12 and 30 months of age, which averages about 6 to 12 months older than mean values at rural sites. While this pattern suggests that relatively fewer sucklings were consumed at urban sites compared to rural sites, it need not contradict the criterion for a consumption site. Younger pigs do provide tastier meat, but pigs reach their maximum weight around 2-3 years of age. It is possible then that urban1 sites imported pigs of maximum weight, in which case a predominance of animals of prime meat age is noted and the criterion for a consumption site generally fulfilled amongst urban1 sites.

It is difficult to determine if age patterns for pigs at rural sites accord with this criterion of consumption. On the one hand, there is an excess of younger pigs, which do provide good-quality meat, and fits the expected pattern of consumption. However, if production at the site was geared towards raising pigs to maximum weight around 2-3 years then slaughter at younger ages would contradict expectations. Perhaps the great fecundity of the pig allowed the farmer to consume many younger pigs, without jeopardizing the survival of the herd. A similar argument has been offered for the case with caprines as well.

(2) A non-realistic herd structure

Whereas production sites should show evidence for many breeding females and few younger males, consumption sites are characterized by the opposite pattern in herd structure, that is, evidence for few breeding females and many younger males. The expendable young males are targeted for eating and sent to consumption sites, while the mature females are retained at the production site for breeding purposes, until they too die or are killed. Their meat, being less tender than that of younger males, is more likely to be consumed locally at the production site rather than moved to sites strictly associated with consumption.

Animal aging and sexing data from Roman period sites in Italy are limited but those available indicate that male cattle, sheep/goats, and pigs outnumber their female equivalents at only one of the urban sites: Pompeii-Ganimede. Thus, this site especially might be labeled a consumption site on the basis of evidence for a non-realistic herd structure biased towards dispensable males rather than breeding females. However, there are other urban sites where an imbalance in sex ratios for one or two of these taxa occurs. Oxen and bulls were more numerous than cows at the sites of Aquileia and Volano, but both of these are special deposits and may not be indicative of general dietary consumption. Two urban1 sites, Altino and Carminiello, reported a fairly equal balance between male and female cattle, and not the expected preponderance of young males had beef been important to the diet at these cities.

A non-realistic herd structure for sheep/goats is noted at many sites, both urban and rural, but the general pattern is one of female predominance. There is no consistency with rural sites recording more older breeding ewes and urban sites more young male lambs and kids. Only two sites, Gravina-pit and Pompeii-Ganimede, showed evidence for a sizable proportion of younger male sheep/goats which fits the modeled criterion for a consumption site.

Linking the presence of a non-realistic herd structure with meat consumption is difficult in the case of cattle and sheep/goat, since males and castrates of these taxa provide important secondary resources such as traction, in the case of the ox, and wool, in the case of rams and wethers. Male animals exploited principally for their secondary products, therefore, will balance the age and sex distribution of the herd, if these individuals too are kept to older ages alongside the breeding females.

Examining for a non-realistic herd structure amongst pigs is perhaps better for determining consumption patterns since pigs yield no important secondary resources which would necessitate keeping many males to older ages. Certainly a few brood boars would be required but most males would be killed either at or before attaining maximum weight. Overall, there are relatively more urban sites than rural sites reporting a male pig predominance. Otranto, Roccagloriosa, Populonia, Naples-Girolamini, Rome-Meta Sudans, Pozzuolo del Friuli, Stufels-Senoner, and Invillino all register more than twice the number of males pigs to females. This supports the hypothesis that these urban sites are principally consumers, at least of pork. Roccagloriosa, Naples-Girolamini, Rome-Meta Sudans, and Stufels-Senoner further conform to the modeled consumption criterion in displaying a predominance of young male pigs in their zooarchaeological data.

Although urban sites tend to show a non-realistic pig herd structure, the data are inconsistent. Male pigs outnumbered females at the rural sites of Via Gabina-site 10&11, San Giacomo, Matrice-period 3, and Monte Barro. Moreover, the data from Monte Barro show a preponderance of young male pigs. This corresponds with criteria of a consumer site, when we might expect these rural sites to have been producing animal resources. As noted earlier, one of the complications of recognizing production is that it is filtered through consumption. Faunal materials from rural sites are generally interpreted as waste from meals at those sites, or in other words consumption discard. A rural site can produce pigs but may choose a consumption pattern which does not differ from the typical menu at an urban site. The bone waste from the consumption activities at both types of sites, therefore, will be similar, with some rural sites also displaying a non-realistic herd structure biased in favour of young male pigs. The degree to which this is evident depends on the success of the herding operations. A wealthier and successful farmer might be able to consume more younger animals without fear of upsetting the reproductive status of the herd, whereas a poorer farmer might be forced to sell younger animals or else raise them to older ages and maximum weights at which point they might be consumed.

(3) Lack of bone debris associated with butchery waste products

The premise behind this criterion is that in most cases individuals at consumer sites do not slaughter the animal and subsequently dress and joint the carcass, but rather that they receive the meat as prepared cuts, often from the meatier sections of the animal. Typical skeletal waste products like the head and lower feet then remain at the production or butchery site, while bones associated with primary and secondary cuts have a greater chance of reaching the consumer and being disposed of in the rubbish there.

On average, primary cuts yield their highest values at urban1 and urban2 sites rather than at rural sites, no matter which domestic mammal taxon is compared—cattle, sheep/goat, or pig. The impression is that primary cuts are being imported into urban1 and urban2 sites from rural sites. In this respect the data fit the modeled criteria of an excess of bone debris associated with better-quality, meatier cuts at consumption (read urban) sites. But do these urban sites also show a lack of bone debris associated with butchery waste products? Overall, the frequency of pig heads and feet is greater at rural sites than at urban1 or urban2 sites, which agrees with the modeled criteria. Urban sites, where we might expect consumption to be displayed, do conform to the anticipated zooarchaeological expectations of consumption sites in terms of the distribution of skeletal parts for pigs.

In the case of cattle, fewer heads are accounted for at urban sites compared to rural sites, which correlates with the modeled expectations. The heads accumulate from slaughter and initial processing waste and thus would remain at production sites, with fewer reaching consumption sites in urban areas. Bones from the cattle foot, however, are relatively more plentiful in urban deposits compared to rural ones. This is contrary to the expected pattern but could relate to a concentration of bone-working and hide-processing industries in urban areas. The feet may have remained in the hide sent to urban tanneries, while the metapodial bones on the lower leg are a valuable raw material for bone-working. In both cases there would be a greater chance of cattle extremities reaching urban areas where they might later be discarded.

The pattern for sheep/goat is different than that for pigs or cattle in that the relative frequencies of heads and feet are fairly equal between the average rural and urban site. There is no excess of butchery waste at rural sites or an excess of primary and secondary cuts at urban sites which might indicate their productive or consumptive status. Instead the sites show similar patterns.

Of course there is much variation in skeletal part frequencies within site type categories. Depending on the animal, some urban1 and urban2 sites such as Schola Praeconum, Pompeii-Ganimede, Carminiello, Populonia, Luni, Modena, and Invillino register a lack of bone debris associated with butchery waste. Thus, the data suggest that at least these seven urban sites can be labeled as consumption sites on the basis of skeletal part frequencies—however, so might a couple of rural sites, especially Matrice-period 2&3 which records a lack of butchery waste from the heads and feet of caprines and pigs. Matrice-period 2&3 therefore also fulfills the modeled criteria of a consumption site in this respect.

(4) Evidence of young animals in the fusion data but not in the dental data
The idea behind this point is that the waste products from animal slaughter, which includes the head, are left behind at the production site, while the better quality post-cranial

segments are imported into consumption sites. Consumption sites, therefore, would register an abundance of young animals in the fusion data, since young animals would form the bulk of the meat consumed. However, at the same time, consumption sites would show few younger individuals in the dental data since these heads would remain with the slaughter waste at the production site.

Four sites (six if "special" sites are included) recorded both fusion and dental data for cattle. Of these, only two sites fulfilled the criteria of consumption site. Populonia, an urban1, site consistently showed this pattern at both the less than one year and the less than two year age categories. Via Gabina-site 10, a rural site, also fulfilled the criteria, but only for cattle in the less than two year category.

More sites recorded dental and fusion data for sheep/goats than for cattle, but the pattern for consumption sites is quite irregular. Examples from all site types fulfill the modeled criteria, but none of these is consistent at both age groups (e.g., less than one year and less than three years). Three rural sites—Matrice-period 2&3, Via Gabina-site 10, and Gravina—conform to some degree to the consumption site criteria in that they register more younger sheep/goats (less that one year) on the basis of fusion data than dental data. However, this is not the case when the second age category (i.e., less than three years) is compared. Populonia, an urban1 site, fulfills the criteria for consumption site, but only when animals in the less than three year category are used. Schola Praeconum, another urban1 site, is the reverse in that it displays the consumption criteria for sheep/goat less than one year. These two are the only urban1 sites to show any sign of sheep/goat consumption on the basis of comparative dental and fusion data.

The situation for pigs is similar to that for sheep/goat in that both rural and urban sites fulfill the criteria for a consumption site. However, urban1 sites tend to be the most consistent over the two age categories used: less than one year and less than two years. The urban1 sites of Modena, Pompeii-Ganimede, and Schola Praeconum satisfy the modeled criteria at both age categories, while Carminiello-period 3 does so at the less than two years level only. A few rural sites, such as Monte Irsi, Matrice-period 2&3, and San Giovanni-period 2&3 variously conform to the criteria of a consumption site at either the first or second age level used. No urban2 sites recorded more younger pigs in the fusion data than in the dental data, but this database consisted of only three sites, compared to twelve rural sites and six urban1 sites.

It is always possible that some whole animals were brought to a consumption site, in which case we might expect to find remains from the entire skeleton. These animals may have arrived alive and been slaughtered and prepared at the consumption site or they could have been purchased as partially-dressed carcasses perhaps gutted, skinned, or otherwise prepared. The ancient sources mention cooking whole sucking-pig and lamb, and we do find the remains of all parts of piglet and lamb carcasses at nearly every type of site. However, no site fits this criterion perfectly in having principally the bones associated with primary and secondary cuts but also those from the entire skeleton of piglet and lamb. Such a pattern indicates import of meat cuts, likely purchased at a market, as well as the occasional whole and generally young animal. We would not expect larger animals such as calves, or adult cattle, pigs and sheep/goat to be purchased since they would yield a great amount of meat which would need to be consumed before spoilage. Smaller piglets and lambs were both tastier, on account of the tender flesh, easier to manage in terms of preparation and cooking, and could feed a smaller group of people with fewer leftovers.

(5) Anomalies between the animals present and the environment of the site

It stands to reason that most animals consumed in urban settings were not raised there. Space was limited and for sanitary and control purposes animals had to be kept separate from humans. Only people with larger yards could consider raising their own livestock in urban areas, but given the Roman penchant for creating pleasure gardens it is doubtful that animals, save perhaps pet dogs and cats, were allowed access to these areas. Some working equids, such as those which turned the grain mills in cities, were likely stalled in urban centres, as it attested in the archaeological record from Pompeii (Richardson et al. 1997), but it seems that most livestock destined for consumption were kept outside. Wild animals, especially the larger ones such as wild boar and deer, could not be raised in urban centres and most certainly had to have been hunted elsewhere and brought into the town. On the basis of this supposition, it appears that practically every urban site, therefore, is a consumption site, since there will be an anomaly between the animal taxa eaten there and the environment of the site.

(6) Literary or textual references alluding to the consumptive nature of the site or area

Everyone has to eat. Meat and other animal products often form a part of the diet, and from the recordings in the ancient texts we know that meat was certainly eaten in Roman Italy. Any site where bone waste is recovered in a context interpreted as cooking or food refuse is by association a consumption site. Most zooarchaeological material is interpreted in this manner. Thus, with the exception of some of the special sites, the animal waste is a link to the meat contribution to the Roman diet.

The ancient texts relate the importance of meat in the civilized diet and document aspects of the mechanics of food provisioning for Roman cities, especially Rome. Urban centres had a large aggregate demand for meat and markets and butcher's shops for its sale and distribution. Thus, the texts indicate that urban sites are consumers, an obvious connection. However, consumption is not site specific. Occupants at rural and settlement sites also require food. Like their urban counterparts, many of these are also wealthy citizens who desired meat as part of their culinary menu. Rural and urban diets therefore, need not be different. Both are effectively consumers, even if the principles behind food acquisition in both cases may vary. Rural consumers may gear their consumption habits around husbandry schemes, whereas urban consumers may not be as restricted, especially if they could afford any foodstuff.

Chapter 9

SUMMARY AND CONCLUSIONS

The focus of this thesis is production and consumption of mammals and mammalian goods in Roman Italy. I have examined this topic using two principal methods. First, I have presented and integrated the two major sources of information on this topic—animal bones recovered from excavation of Roman period archaeological sites in Italy, and references relating to mammals and their products in the ancient Latin texts—to develop a more complete understanding of the role of mammals in the Roman diet and economy. Second, I have tested these data sources against a model (i.e., producer-consumer model), which outlines general characteristics of mammal production and consumption and provides a less ideographic framework for their interpretation. In this chapter I summarize the findings for each of these methods under the following headings: (i) integration of zooarchaeological and textual data about mammals in Roman Italy; and (ii) modeling production and consumption of mammals in Roman Italy. I conclude with some recommendations for future research.

(I) Integration of Zooarchaeological and Textual Data about Mammals in Roman Italy

Textual and archaeological data can be both "interdependent and independent, complementary and contradictory" (Little 1992a: 4); only by comparing these two sources can we recognize the strengths and weaknesses of each, as well as identify gaps in our understanding which are not served by either. Despite the interrelated nature of zooarchaeological and textual data in terms of understanding the role of animals in Roman Italy, however, the traditional disciplinary boundaries have often separated them. Zooarchaeology is usually linked to Anthropology or Archaeology departments, while the analysis of ancient texts falls under the jurisdiction of Classics or Classical Philology. The connecting discipline here—Classical Archaeology—has traditionally been interested in the analysis of cultural remains such as pottery, coins, and architecture, and not with animal bones, even though bones, like ceramics and other material goods, are in essence "artifacts" which can yield much information about the cultural realm (Bailey 1991: 15). The mix of disciplines and interests creates problems. Archaeologists, well aware of the "cult of authority surrounding the written record" (Little 1992a: 5), tend to favour their own findings in relation to written record, but at the same time are often guilty of being selective in their use of textual material by picking and choosing whatever seems to bolster and illustrate their archaeological interpretations (Feinmann 1997: 372). Similarly, classical philologists and historians may use archaeological data intermittently to substantiate some argument, but some would rather give credence to "an off-the-cuff remark in the text of Pliny the Elder (than)...hundreds of pages of archaeological reports" (Rowland 1992: 152). I believe both sources provide important information, and have tried to avoid unfair argumentation by including animal information from the entire set of zooarchaeological and textual data available for Roman Italy. Although mammalian production and consumption is only one aspect of Roman life, there is still a great deal of zooarchaeological and textual data on the topic. A complex pool of animal bone data from 73 different archaeological sites provided the zooarchaeological component, which was set against a database of over 2,000 ancient textual references pertaining to animals, meat, and related economic and dietary topics.

No matter how expansive or informative a database may seem to be, there will always be problems associated with its analysis. Perhaps the greatest of these, in terms of both the zooarchaeological and textual material, is that we are continually dealing with samples. Our available database of bones and texts is but a small set of what was originally deposited or written. A sample of animal bones will rarely reflect upon an economic system in its entirety, but rather upon aspects of it. Similarly, the individual texts provide glimpses into the world of antiquity but never detail every possible facet of it. Even when we combine all the zooarchaeological and textual material to augment our database there is still no guarantee that those pieces missed in an individual analysis will be covered by such a fuller and broader study. Nevertheless, only by integrating these samples can we hope to distinguish patterns in the data, from which we may either identify strengths and subsequently draw conclusions, or establish areas of weakness that require further research, perhaps with the aid of other sources of data, or with the use of different theoretical perspectives.

The bias of sampling is further compounded when we factor human error and selective analysis into the equation. It is difficult to compare zooarchaeological data and their interpretation among sites when both the quantity and quality of analytical research conducted at each varies. Failure on the part of the original researcher to perform a thorough examination of the bone material, or omission of results can mean a faunal report is of less use to any subsequent zooarchaeologist. Moreover, even fairly complete faunal studies may be trimmed for publication, with only select aspects reported. Often the list of bone measurements (assuming they have been taken) is cut first. This disregards an important source of breed and size information.

Another major problem associated with using texts and zooarchaeological material is that both sources must be contextualized to be assessed properly. This is a formidable task for even a single zooarchaeological sample or the writings of one ancient author, let alone a great number of these. In fact, it is probably impossible to understand the full context in most cases, especially given that we are forced to rely on samples from incomplete databases to obtain this information. How can we attempt to contextualize the writings of Varro, for example, when we have only few details of his life and the world in which he lived and wrote obtained from a handful of archaeological and textual references? Moreover, how can we fit a zooarchaeological sample into its wider context when we still cannot identify, let alone understand, all the cultural and natural factors that formed this sample? The issue is further complicated when we consider that our interpretations of textual and archaeological data are influenced by the social context and situation that we experience as well, and that this is unique to every individual. Both textual and archaeological data have no fixed or universal meanings or interpretations. Each source is somewhat ambiguous, and neither can be contextualized in a complete and indisputable manner.

While we can probably never fully contextualize the textual and zooarchaeological database, such a process still must be attempted to reduce bias. The zooarchaeological data used in this thesis derive from different types of sites separated in time and space, and were collected and investigated using a range of techniques and procedures. Controlling these biases and trying to contextualize each zooarchaeological sample are ominous tasks. There are many levels. First, each faunal sample must be interpreted in light of the natural and cultural factors which created it. Second, the faunal sample must be related to the rest of the site. Finally, for a full contextual analysis the site must be placed within the larger archaeological picture.

I have considered the effects of preservation and recovery biases on the nature of the individual faunal samples used in my analysis, and compensated for the differences exhibited. Recovery biases were controlled to some degree by concentrating subsequent analyses on the medium and large domestic animals—specifically cattle, caprines, and pigs—the bones of which have a fairly equal chance of being recovered in both trench/trowel and screening operations (Barker 1975; Steele 1983). Taphonomic conditions present another bias. While these certainly varied among sites, and were not consistently reported or discussed, the fact that teeth comprise less than 40% of the total cattle+sheep/goat+pig NISP figures at nearly 90% of the sites used, as shown in Table 12 and Figure 2, suggests that preservation and taphonomic conditions were not considerably different among the vast majority of sites. Thus, they too are controlled to some degree in this thesis. Zooarchaeological patterns, therefore, can be interpreted with a certain measure of confidence that these are not simply the result of varying recovery and taphonomic biases, but instead presumably reflect dietary and economic aspects of the Roman people.

In regard to the second level of zooarchaeological contextualization, the relationship of the individual faunal samples to the rest of the site was somewhat ambiguous in many cases. The depositional context for the special sites was usually outlined (e.g., burial in a well or grave), since this was often what made the sample distinctive. At some sites, faunal materials were collected from recognized middens, and accordingly labeled as food and/or butchery waste. However, in many cases the context of deposition was not known but the faunal materials were assumed to be food and processing waste. Often this assumption is warranted since the presence of butchery marks on some bones from practically every site attests to at least some food processing activity, but again without complete depositional information one cannot be positive about the nature of the sample.

Ideally, for complete contextualization, a zooarchaeological sample and the site from which it came should be related to the larger archaeological picture. Often this is attempted in archaeological interpretation but practical constraints and research goals limit what aspects will be considered and the scale of inter-site synthesis.

References to animals are spread throughout the various types of texts, with the bulk contained in the Roman agricultural manuals. These textual data are also distributed temporally; most date from the 1st century BC to the 1st century AD. Contextualizing the animal information contained in these ancient texts is a challenging and ceaseless venture.

Basically, some idea of the author's intentions in writing is necessary. I have categorized the ancient texts according to literary genre or types and commented about the nature of the animal references from each of these text types. While exceptions do occur, overall most of these references are judged to provide fairly reliable information about the role of animals in the Roman diet and economy, even if much of this needs to be considered within the context of a typically elite Roman audience. Several are blatantly fanciful or somewhat exaggerated to accord with the literary experience the author chooses to create, or to emphasize a particular moral or personal issue (e.g., the exotic dishes in Petronius' *Satyricon*; Virgil's [*Ecl.* 3.29-30] "super" cow with its seemingly limitless energy and supply of milk; the Elder Pliny's tale about swimming pigs [*NH* 8.77.208]). Nonetheless, even these appear to be based on some observed or at least hypothetically probable phenomenon. The fact that a number of authors repeat important and basic information about animals in Roman life suggests that at least those recordings are true. For example, Roman agronomists, poets, satirists, letter writers, law codes, and inscriptions all mention using cattle to pull the plough on farmsteads. While it is possible each source just borrowed this information from another, it is more likely that this was simply common knowledge, probably based on personal observation or expert authority in each case. If these repeated bits of information can be assumed accurate then why not those which are not repeated? Presumably, an audience would not want to be told false details about animals, especially from the agricultural writers whose purpose was to educate them about proper farm management and husbandry techniques. Of course, the upper-class bias still applies, but I would argue that what is presented is accurate and reliable in this context at least.

Despite the many challenges associated with contextualizing zooarchaeological and textual data, there is still great benefit in integrating the two sources. Clark (1992a: 65) summarizes the problems and potential of using archaeological and historical documentary data for Medieval Italy:

> It is obviously potentially difficult to return to published archaeological data with new questions. However, even in the examples discussed here, the relevance of the historical documentary sources is clear. For such information may allow us to interpret, rather than purely describe, patterns observed in the material from [archaeological] sites.

A similar case can be made for Roman Italy. Zooarchaeological and textual sources each contribute information about the role of animals in the Roman economy and diet. At their core the zooarchaeological data essentially provide patterns which require some explanation. The texts suggest and document criteria which can be used in these explanations. In the case of those mammals eaten, such as cattle, caprines, and pigs, the zooarchaeological data are biased in favour of consumption, since the deposited bones of these taxa often represent either butchery and processing waste, or the remains discarded from meals. Production can be viewed through the filter of consumption, but the relationship is not always made clear, especially when we consider that many factors can influence what is consumed.

The ancient texts, on the other hand, provide particulars about both production and consumption of animals in Roman Italy. The Roman agricultural writers supply the majority of information about animal husbandry schemes but principally from the vantage of ideal and large-scale farming or herding operations. Consumption too is biased in favour of the privileged and elite, even though some references—such as quotes of prices, details about markets and fairs, or comments on food distribution schemes—presumably relate to a more general population.

In most cases what the texts record agrees with the picture developed from the analysis of the zooarchaeological data. The integration of these two data sources for the various topics of production and consumption has already been discussed in their individual chapters above, so I will not detail specific points here. It is challenging to summarize the key points about the role of mammals in the diet and economy of Roman Italy since there is a tremendous amount of regional, temporal, and site-specific variation which must necessarily be simplified in the process. Although I do recapitulate what I believe to be some of the major points about mammalian production and consumption in the individual summaries which follow, my principal goal in this section is to identify the general strengths and limitations of their collaborative analysis in terms of the individual subtopics—notably husbandry, diet, butchery, and cooking—which comprise the main aspects of production and consumption as revealed in zooarchaeological and textual data.

Production

Cattle Husbandry

Zooarchaeological data show that cattle, sheep/goat, and pigs were the focus of the animal economy in Italy and contributed the bulk of the meat to the Roman diet there, regardless of geographic region, temporal period, or site type. Cattle, sheep/goat, and pigs are also the principal animal taxa referenced in the ancient texts. The results of the integrated analysis for cattle reveal considerable overlap. Most individuals were kept to older ages and used for traction, a condition confirmed by zooarchaeological age data and the relatively high incidence of stress injuries on cattle leg bones compared to other animals. Rural sites record fairly low cattle frequencies compared to other site types which is expected if these animals were not regularly raised and consumed on the farm but rather reserved for work purposes. Frequency figures are highest among sites in northern Italy, a pattern which agrees with textual references indicating the principal locations for ranching and dairying operations. Their relative numbers decline over time in central and southern Italy but remain stable in the north. While northern cattle are shown to be smaller than their central and southern counterparts, all three regions display a progressive size increase over time, presumably the result of improved breeding conditions.

Sheep/Goat Husbandry

Zooarchaeological and textual data about sheep/goat husbandry also correlate in many respects. Their combined zooarchaeological and textual analysis reveals a range of husbandry operations, from transhumant movement of flocks of varying size to the keeping of only a few individuals at the farm all year. Sheep outnumber goat, which is expected given the importance of wool in antiquity, and their frequency shifts over time in relation to the changing demands of that industry. Sheep are most numerous relative to other animal species in areas of southern and northern Italy which are noted for pastoralism by the ancient authors.

Pig Husbandry

Pig bones were found at nearly every site used in this thesis; their frequencies often surpass those of all other animals. They are most numerous, relative to cattle and sheep/goat, among sites in central and northern Italy, a pattern which accords with textual references about husbandry operations. Their values tend to increase over time, presumably indicative of their enhanced economic role and increased dietary popularity, as supplemented by textual records. Herd sizes varied considerably, and there is evidence for the practice of annual and biannual breeding schemes in both the zooarchaeological and textual data. Most pigs did not survive beyond three years of age, with males preferentially killed as younger individuals. Moreover, withers height analyses reveal the existence of different breeds of pig, a finding which is verified in the ancient texts.

Animal Husbandry in General

Customarily, the assumption that agriculture was rational and organized around some type of market economy is made for antiquity.[119] In the case of animals then, those consumed, or otherwise integrated into this economically rational scheme, are viewed as deriving from husbandry operations geared towards increasing or at least stabilizing the number of individuals in the herd. Zooarchaeological data show that most cattle consumed at Roman sites in Italy were older individuals. The texts affirm that cattle were often used as work animals, and specifically kept to older ages for this reason. Sheep predominate over goats at most sites, and generally older individuals are represented. Again, the texts suggest that this is the expected pattern for an economy where wool and cheese exploitation held precedence. Pigs were important meat animals, as noted in the texts. Zooarchaeological data correlate with these findings in that most pigs were killed either at, or before reaching maximum weight. Keeping them any older would put an extra drain on feed resources and not see a corresponding weight gain in the pigs. Overall, the animal bones suggest that Roman animal husbandry schemes were economically rational.

Zooarchaeological and textual data are quite complementary to an investigation of animal husbandry techniques in Roman Italy. Perhaps their greatest integrative value comes in terms of the analysis of animal breeds and the recognition of breeding improvement. The texts offer details about the physical appearance of animal breeds (i.e., colour, shape, wool/hide/skin texture, etc.) but only vague accounts of animal size. Zooarchaeological data yield no information about (usually) perishable products such as wool and leather; however, they do provide a large database of metric information which is crucial to the reconstruction of size distributions among animal individuals and populations. Zooarchaeological metric data further inform us of temporal changes in animal size resulting from long-term breeding improvements. The ancient authors miss much of this information simply because such changes take generations to occur, and consequently extend beyond the scope of one author's lifetime.

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[119] Although not without much debate. Engels (1990: 26-27) rejects the primitivist notion that Greco-Roman agriculture was pre- or non-rational, citing the sensible advice of the Roman agronomists (i.e., "grow labor intensive crops near the city and less intensive crops further out, analyze which crops are grown successfully an unsuccessfully on neighbouring farms, economize on labor and materials where practicable, and above all understand the demands of the urban market") as proof that a rational system of agricultural markets existed.

Consumption

Butchery

Butchery is required to reduce the animal into meat portions. Chop, cut, and saw marks left on animal bones inform us about the equipment and procedures used in carcass butchery at Roman sites in Italy. Zooarchaeological evidence shows that a fairly standardized pattern of butchery was practiced for the different animal taxa, with cleavers and choppers as the principal tools used. The texts provide little information which addresses animal butchery, but they do describe techniques for preserving meat. In this manner the two sources complement each other, with zooarchaeological data providing information about animal butchery and the texts detailing methods of the subsequent preservation of the meat, assuming all meat was not consumed fresh.

Cooking

Despite the importance of cooking in the preparation of meat for consumption, the topic is fairly rudimentary compared to broader issues such as reconstructions of animal husbandry techniques or the examination of the social and economic role of meat in the Roman diet. Consequently, the zooarchaeological and textual data on the subject are somewhat meager or basic by comparison. The ancient texts detail the five basic cooking methods used by the ancient Romans (i.e., boiling, roasting, frying, grilling, and baking), and detail recipes involving each. They further indicate that boiling and roasting were the more popular choices, a finding which is supported to some degree by zooarchaeological examples of burnt bone, perhaps due to roasting, as well as faunal indications of a rather haphazard butchery pattern at some sites, suggestive of reducing the carcass to pot-sized stewing pieces.

Diet

The three taxa discussed above (i.e., cattle, sheep/goat, and pigs) all contributed resources to the Roman diet. The zooarchaeological and textual data generally overlap in the initial stages of this analysis by noting the species consumed and ranking their dietary importance; however, both sources are crucial to any further study seeking more specific information. Zooarchaeological data reveal the significance of beef to the Roman diet, a point which is trivialized in the texts. Pork was also a popularly consumed meat, especially at urban sites, but in this case both bone and text data agree. Zooarchaeological examination provides a great deal of information about the movement of animals and meat cuts and their relationship to rural/urban and poor/elite diets. Urban sites certainly imported whole animals but they appear to have received relatively more better-quality cuts of meat, as indicated by the skewed distribution of skeletal parts among site types. However, they also register an abundance of cattle extremity elements which may relate to tanning industries. In contrast, rural sites generally record fewer primary cuts, thereby suggesting export, but the higher frequency of bones from wild animals at rural compared to urban sites indicates that game formed a greater part of the rural diet. Textual references assist in areas where zooarchaeological data are of limited value, specifically in describing the dietary contribution of animal products such as milk, cheese, internal organs, and meat filleted off the bone.

Principal Limitations of Combined Zooarchaeological and Textual Analyses for Roman Italy

While combined zooarchaeological and textual analyses aid in our understanding of many aspects of animal production and consumption in Roman Italy, they both fall short in two major areas. The first deficiency concerns the contribution of small-scale herders and farmers to the general Roman economy. The texts offer few details; both they and the zooarchaeological record have an upper-class bias. We have few archaeological examples of peasant dwellings and no faunal samples from such contexts. Moreover, most ancient texts were produced by and for the elite.

A second deficiency of both the zooarchaeological and textual data is their combined limited value in identifying distribution mechanisms. Markets, fairs, shops, and other centres of distribution represent an important link between the production and consumption of goods. Although these places are referenced in the ancient texts and discussed elsewhere,[120] we know little about the mechanics of sale and trade of animals and animal products at Roman them. Furthermore, there are few details concerning the provisioning of these distribution centres in terms of the actual movement of goods via land, river, or marine routes. Much of our knowledge about these procedures, although often rational and believable, is still somewhat speculative in nature, and difficult, if not impossible, to test empirically. Even if the data were available, it would still be difficult to isolate and understand the many components which created and affected them. Food distribution in any complex society like that of Roman Italy is often an elaborate process which is influenced not only by the society's political and economic organization, but also by numerous other factors such as social stratification, gender, and specialization (Gumerman 1997: 117-119).

Linking Sites in Roman Italy on the Basis of Zooarchaeological and Textual Data

Is it possible to draw links between sites on the basis of the zooarchaeological and textual evidence? Certainly connections occurred amongst sites in antiquity but at present there are not enough data to allow us to link any of the archaeological sites together in any sort of producer-consumer relationship. Possible, perhaps even probable connections might be made. The rural villas of Le Colonne and Settefinestre could easily supply animal resources to the neighbouring city of Cosa, and were not too far to provision markets at Rome and/or Ostia. The city of Rome would also be a major consumer for any animal products produced at its own suburban sites such as Via Gabina and Quintili. Moreover, it could also receive goods transported over great distances, such as pigs from Lucania (e.g., site of San Giovanni) or Samnium (e.g., site of Matrice in Molise). Both San Giovanni and Matrice register high frequencies for pigs in their faunal data which suggest some measure of pork production. Taxation in kind may have been the impetus, especially given the fact that production at these sites appears to increase when this tax was implemented.

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[120] See note 17 above.

Matrice may also have played a role in providing animals to the neighbouring urban settlement of Saepinum.

It is more risky to attempt to link other sites. Certainly the urban sites in the Bay of Naples area (e.g., Pompeii, Capua, Naples [Santa Sofia, Via San Paolo, Santa Maria la Nova, Santa Patrizia, Girolamini, and Carminiello]) required meat and other animal products, but there are no zooarchaeological data from corresponding rural sites in the area to hypothesize any connections. Similarly, the urban sites at Otranto, Luni, Pistoia, Modena, Aquileia, and Altino would have required foodstuffs, but in the absence of zooarchaeological data from the surrounding areas it is impossible to determine how exactly these cities were provisioned during antiquity. I suspect that none of them had the alimentary demand that a mega-city like Rome would have had. Presumably then, none imported foodstuffs from any great distance. Coates (1965: 105) and Platt (1976: 75) record that 20 km is a reasonable distance for a farmer's daily travel to an urban centre during Medieval times in Britain, and a similar figure is suggested for Roman Italy. It seems sensible to assume then that smaller-sized Roman towns were principally supplied with foodstuffs produced in about a 20 km radius of land outside the town.

In contrast, supplying the city of Rome with food is always a special case. Rome could not be supported solely by the resources in its hinterland and had to import foodstuffs from elsewhere. Part of this demand may have been satisfied by taxing regions for goods, be it grain from Egypt and Africa, or pigs and pork from central and southern Italy. Outside of these obligatory provisions, however, Rome certainly still required more foodstuffs. Its draw may have been substantial enough to coax or coerce rural producers from relatively distant regions within Italy to provide meat and animal products for the markets in Rome. Given the expenditures involved in transport, I suspect that only the wealthier producers, operating the larger farmsteads, could afford to take advantage of the food demand in Rome. Thus, it is entirely possible that relatively grand rural farm sites like Settefinestre, Le Colonne, Lugnano, and San Potito—all located more than 50 km from Rome, but not over 200 km—provided animals for the markets in Rome. Beyond the 200 km limit, however, the costs of transport would certainly inhibit extensive shipments of goods or the herding of animals, unless these were transhumant flocks which might normally be driven over great distances.

The problem in linking any of these sites is that they represent only a tiny fraction of what existed during Roman times in Italy. The temptation exists to "connect-the-dots," so to speak, and create links that really cannot be verified on the basis of present data. Comments in the ancient texts such as Pliny the Younger's (*Ep.* 2.17) decision to sell the goods produced at his rural estate at the markets in Ostia rather than the ones in Rome, as well as Virgil's (*Ecl.* 1.33-35) denouncement of the "thankless towns," which drain rural producers of their resources, inform us that connections did exist, but it is impossible to conclude this or any other potential urban-rural links on the basis of available zooarchaeological data.

While I suspect few animals from distant areas were brought to cities other than Rome specifically for butchery and consumption of meat, the situation may be different in the case of other animal resources. On the basis of textual references we know that some livestock was also sold at urban markets (e.g., Aquileia [*CIL* 1.2.2197]; Frayn 1993), but it is impossible to tell what percentage this comprised in relation to livestock trade and sale elsewhere, such as at rural farmsteads, smaller settlements, or periodic markets or fairs. Nevertheless, Roman animal breeders were encouraged to raise quality stock, and the progressive increase in average animal size, as shown in the zooarchaeological withers height data, suggests that brood stock improved over time. There would certainly be a demand for good-quality brood stock, otherwise the Roman agricultural writers would not detail the physical characteristics of the best breeding animals to the degree that they do. Given their more mobile nature as transhumant flocks, I suspect more caprines than other animals were herded to a market or fair where individuals might be sold as brood stock, or selected for various characteristics such as wool quality. Some common gathering ground would be needed to display the various animals. Cattle might also have been sold or traded there, but probably fewer pigs in relation to these other animals. Pigs would have been harder to herd to market, especially over any long distance.

(II) Modeling Production and Consumption of Animals in Roman Italy

Models aid in simplifying and interpreting archaeological data, and should only be considered heuristic devices for manipulating observations and hypotheses. By their nature they are predictive and malleable frameworks, which can and should be modified as fresh observations are made and fresh hypotheses tested. Models mirror only selected aspects of the observations; therefore it is possible to have different models based on different social, political, economic, religious, etc. vantage points which attempt to explain various aspects of a single situation (Clarke 1972: 4). It is a general property of models that many different models will fit a given situation. In other words, there is a great pluralism when dealing with models. Given this fact, therefore, an archaeologist can easily find himself/herself overwhelmed attempting to understand fully all parts of a seemingly simple aspect of an ancient culture like the animal economy. Although the entirety of answers cannot be sought with one model, its use nevertheless initiates the process to achieving this goal.

The economic complexity model developed by Gillian Clark (1987) and adapted in my analysis here of the zooarchaeological and textual data about mammals in Roman Italy helps to simplify and explain phenomena concerning production and consumption. In general, the data conform to the modeled criteria, with rural sites usually showing patterns typical of "production" and urban sites those of "consumption." Nevertheless, there are problems with the model, as well as aspects which it cannot address. These require further discussion, which I here group under the following headings:

Labeling and Quantifying Production

As I have noted on several occasions throughout this thesis, it is easier to study diet and consumption of animal resources on the basis of excavated bones than it is to infer production. Most of the bones collected represent the remains of animals which were ultimately eaten, and thus provide a direct link to the diet, even though all of these animals once formed part of some husbandry operation on whatever scale, and where many may also been exploited for renewable resources such as milk, wool, traction, or manure, prior to their slaughter. It is important to realize that the food consumed on a site need not necessarily reflect the production schemes implemented.

Problems of quantification and sample representation in faunal studies hinder accurate investigations into the productive nature of a site. As noted in Chapter 6, zooarchaeological data fail to yield numerical evidence for a "surplus" of animals at any site, regardless of how "productive" that site may be on the basis of other criteria. Extracting evidence of a surplus of animals exclusively from the recovered bones is extremely difficult, if not impossible.

What can be done about the problem of recognizing and labeling production? One solution might be to examine other archaeological or textual indicators of production at the site. It the case of Roman farms, this seems obvious since many have agricultural facilities or other structural features which suggest some degree of surplus production (assuming they were used and are not simply relics). In other cases, relevant artifacts and inscriptions may provide further evidence of the productive nature of a site.

A second possible approach is as King (1988: 52) suggests:

> to ignore, for the moment, the production side of...animal economies, and instead concentrate on diet and its variations on the different sites...so that a fairly comprehensive picture of consumption patterns can be built up. Once these patterns are known, models of production and distribution can be put forward to try to explain the relationship between surplus production and consumption.

I have adopted this approach to some degree in my examination of dietary patterns among rural and urban sites in Roman Italy using zooarchaeological data (see Chapter 7), and conclude that there is an overall difference between site types. As is discussed more in Chapter 7, rural sites generally display an export of meat cuts, while urban sites usually record an excess of primary cuts. The data support the hypothesis that rural sites were active in animal production.

Age and Sex Data

Many of the criteria for the economic complexity model rely on distinguishing specific age and sex patterns in the zooarchaeological data. Unfortunately, determining both age and sex from animal bones is a difficult and complex topic. Aside from all the taphonomic and recovery biases that can affect that part of the sample which is eventually aged and sexed, there are problems associated with each method. Fusion and dental eruption data must often be interpreted within variable and sometimes quite broad age brackets. Dental wear stages are both age and diet dependent, and consequently are not easily translated as a chronological age. Few bones provide unambiguous information about sex, and there is considerable overlap and associated problems when trying to infer sex from osteometric data. Moreover, the bone changes involved in castration are not fully understood or visible.

While the variability and ambiguity associated with aging and sexing animal bones are not faults of the modeled criteria, they nonetheless greatly hinder the recognition of those criteria. Methods which allow for more specific and reliable determination of age and sex from animal bones would greatly improve the use of the economic complexity model.

Distinguishing Exchange Mechanisms

On the basis of the dichotomous relationship between city and country, urban and rural, consumer and producer, there is a tendency to assume that a market economy existed, which was fueled by processes of supply and demand. Rural producers sell goods to urban consumers. Currency, either coins or other goods, changes hands. But although a market type of economy did exist in Roman Italy, it was not the only form of exchange of animal resources. This presents a problem which Clark (1987: 157) originally acknowledged:

> although it is possible that the movement of animals might be recognised, it may well be rather difficult to distinguish the precise exchange mechanism [e.g., whether extended family inter-site exchange, contractual supplies, or reciprocal inter-site exchange].

The zooarchaeological data for Roman Italy provide no information about small-scale exchanges of animals or animals goods, be this at the level of gift giving, barter, or sale between neighbouring farms or over longer distances. These exchanges would leave little osteological evidence unless butchery took place on a regular enough basis for the animal bones to survive in any recognizable quantity. From the texts, however, we know that such exchange mechanisms existed. Moreover, they were probably much more common than recounted.

Contractual agreements of animals and animal products also existed in antiquity, but again cannot be reconstructed from the available zooarchaeological data. The texts outline agreements for renting work animals and flocks of sheep in particular, with various legal arrangements made for the use of them and their products.[121]

Redistributive systems also operated in Roman Italy and pose another challenge to the interpretation of animal bone data. Taxes create strong demands on producers, which are not necessarily the same as those generated by a market economy. Taxation in kind is potentially stressful since it does not afford the producer the option of paying in cash. He must concentrate his efforts on amassing often a single product without the insurance of other commodities. If his product were to fail, the repercussions could bring economic disaster.

Attempting to locate and characterize redistributive schemes incorporating animal resources is difficult on the basis of the faunal materials alone. Determining their existence and impact depends upon the nature, frequency, and severity of the redistributive system. Taxes collected gradually over an extended period of time may leave no distinct trace among the faunal remains. On the other hand, accumulated taxes collected only occasionally might be represented by marked peaks in ages at death, representing the culling of a large number of animals at a single time. Here, production levels would likely be set so as to allow for increased consumption at certain times. We know that Roman taxes were collected annually, therefore we might expect to see their effects displayed more conspicuously in the faunal record, perhaps as a marked annual slaughter to correspond with tax time.

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[121] Lirb (1993) and Martin (1990) provide examples of renting and leasing animals during antiquity as described in the ancient texts.

Taxation in kind may be easier to recognize in the zooarchaeological data than small-scale exchanges between sites, or contractual agreements. However, available data still produce an ambiguous picture. The site of San Giovanni is one possible candidate for viewing the effects of imperial taxation for pigs during Late Antiquity. The collection scheme is outlined in the texts, particularly the Theodosian Code, and the zooarchaeological data support a great increase in pig husbandry and pork production at the site coincident with the implementation of this tax (MacKinnon, in press). Other factors, such as the presence of horse bones and horse stables at San Giovanni (and lack of mules and donkey remains) in light of ancient documentation stating that riding horses was, at this time, restricted to governors, veterans, decurions, and swine collectors (*CTh* 9.30.14. [AD 364-390]) lends support to the hypothesis that the site was involved in pork tax collection (MacKinnon, in press). While an argument for taxation in kind might be made for animal production at San Giovanni, it is not the only possibility. Pigs might also have been sold or exchanged at local markets, or even at the site itself as part of contractual, reciprocal, bartering, or another exchange mechanism, be it among individuals or groups of people on various social levels.

Finally, it should be mentioned that cities need not dominate the demand aspect of supply and demand. Any nucleation of population, such as a military camp, could generate a sufficient demand for animal resources. This could affect the productive nature of neighboring rural regions to various degrees and for various lengths of time. On the other hand, sites which produce a different product may themselves consume a vast amount of animal resources. For example, a bone workshop, a glue factory, and a lard or marrow production center might all discard great amounts of bone which is not to be interpreted as food or butchery debris.

The Cultural Context

If we assume rural sites to be chiefly producers of animals and urban sites to be predominantly consumers of them, then why do the zooarchaeological data not always fit the modeled predictions? We might expect rural sites to show a mix of production and consumption, given that animal husbandry was generally concentrated at Roman farms in the country but keeping an awareness that many of the bones deposited at these rural sites derive from animals consumed there. It is puzzling, therefore, that some urban sites show, somewhat unexpectedly, patterns which are normally associated with animal production. The answer may lie in the complicated nature of the cultural context. The economic complexity model measures economic and dietary behaviours as reflected in patterns of faunal remains. Animals themselves are obviously constrained by natural and biological conditions. However, diets and economies are inextricably linked with a host of other cultural factors, including social relations, political and legal influences, ideological practices and beliefs, and technological development and availability. All of these factors can influence, in both a direct and indirect fashion, the dietary and economic decisions and choices made by a culture. They intertwine in incredibly complex ways, making it virtually impossible to disentangle completely and understand fully the effects of individual components.

Let me illustrate the importance of the cultural context in analyzing production and consumption with an example. One observation in the zooarchaeological data which does not accord with the modeled criteria for both production or consumption is the relatively high number of mature male pigs among all sites. Under ideal circumstances we might expect producer sites to show relatively more older females, while consumption sites would be biased in favour of young males. Why then so many mature males? The pattern may relate in part to recovery and taphonomic factors, with the larger male canine teeth (the sexual marker in the case of pigs) preserving better and being recovered to a greater degree than its female equivalent. Other variables may have played a role. Perhaps the mature male predominance is a reflection of a more relaxed husbandry scheme where pigs foraged in the forests and were less subject to breeding and culling controls enforced by more stricter husbandry regimes. This in turn impinges on land access issues which themselves contain complex social, political and legal topics. Alternatively, the discordant pattern may relate to gustatory preferences, themselves in opposition somewhat to rational economic behaviours. The Romans may have liked the taste of adult male pigs enough to warrant keeping these animals to older ages. Other factors may have contributed. The point of this example is to highlight the complex interplay of cultural and natural factors which influence the choices made by both producers and consumers. There are no easy answers.

While there are difficulties associated with the economic complexity model, and inconsistencies which arise when it is tested using the zooarchaeological data from Roman period site in Italy, this is no surprise. Clark (1987: 157) admits that "it will be extremely rare for the patterns to be as clearly cut [in the archaeological data] as shown [in her model]. However, even from the blurred images, impressions may be gained and techniques may be developed further." This, I believe, is the real power of any model. It prompts us to re-examine data in a different light.

Future Recommendations

Where do we go from here? I have several recommendations for future studies of zooarchaeological remains from Roman Italy specifically, as well as suggestions for analyses seeking to understand the role of animals in the ancient diet and economy.

First, there is a huge database of archaeological literature and scholarship on Roman Italy, but not all of this is accessible. I repeat the plea by Curti, Dench and Patterson (1996: 189) that "the regular publication of a volume of Archaeological Reports on Italy...by an appropriate scholarly body or journal would be of immense value to all those working in the field and beyond," and suggest that such a publication make reference to any specialist work, such as faunal and botanical analysis or geomorphological research, or noteworthy finds, to facilitate selective research.

Second, the faunal reports I have used in this thesis adopt a variety of methodological and analytical techniques (not all of which are explicitly outlined or referenced), and differ widely in the amount and type of information noted and eventually reported. Although I applaud the testing of new methodologies in zooarchaeological analyses—how else can the discipline develop?—some degree of standardization is required so that faunal samples can be more easily compared and more intensive regional analyses conducted. Basic data on taxonomic abundance, skeletal part representation, age, sex, butchery, and abnormalities should ideally be reported, in addition to full details about recovery and taphonomy. Measurements, taken using the standardized methods of von den Driesch (1976) and Morales and Rosenlund (1979), should also be listed or made available otherwise. The problems associated with the lack of a standardized approach in faunal analyses have plagued the discipline since its inception and prompted zooarchaeologists to develop research "blueprints" or procedural guidelines of topics to be covered and reported (e.g., Baker and Clark 1993; Grigson 1978).

While standardized methodologies and reporting facilitates inter-site comparisons of syntheses in zooarchaeology to some degree, zooarchaeologists must also thoroughly examine the many biases which affect their research. Extensive research has been conducted to understand the great range of these, but there are always complications. Many zooarchaeologists combine bone assemblages recovered from different areas of a site or from different temporal phases at a site to achieve a larger assemblage, which by nature of its size (or "scale" [Winder 1996]) is often believed to contain less bias than comparably smaller samples. However, as Winder (1996) has demonstrated, larger samples do not eradicate bias. In fact, larger samples have more evidence for differential preservation than do smaller ones in his example from Phylakopi (Melos) (Winder 1996: 63). Moreover, distinct patterns revealed in analyses of individual assemblages (be these separated spatially or chronologically) at one site may be lost in any study where samples are combined. Zooarchaeologists are aware of these problems, but often they are not expressly addressed in faunal research. Winder's (1996) proposal of a multifactorial approach where the effects of both intra-site (or 'lateral') variation and inter-phase (or chronological) variation are considered simultaneously, however, is impossible to test in the context of this thesis. It requires data on intra-site and inter-phase separation of faunal materials at each site, material which was largely unavailable for most of the Roman period sites in Italy used here. Nevertheless, his approach holds considerable promise for future investigation.

Finally, archaeology can only benefit from studies that do not just utilize, but combine, a range of data from different disciplines. Bailey (1991: 16-17) spurns the compartmentalization and subsequent separation of existing disciplines as conventionally defined—archaeologists vs. specialists, sciences vs. humanities—advocating instead the implementation of "hybridization" schemes, wherein individuals with expertise or training in archaeology and other relevant disciplines conduct integrative research. The importance of combining multifaceted data from different disciplines in archaeological study is self evident. However, such integrative or hybridized analyses achieve enhanced value and recognition when they stretch beyond observation, description, pattern recognition, and basic interpretation at the site level to deal with explanation on a much broader regional scale. This is especially true for zooarchaeological research, which has traditionally held a somewhat subsidiary role in Classical Archaeology. Thomas (1989: 436) notes that "only with the increased use of the regional approach will archaeologists regard faunal studies with the same credibility as traditional forms of evidence such as pottery forms and tool type." Jones (1991: 8) concurs stating that " the pre-eminent need for synthesis is on an inter-site, thematic basis." It is only when detailed, interdisciplinary regional studies are carried out that significant patterns will become observable.

Nevertheless, although the path to this type of zooarchaeological research should be followed, it is still difficult to traverse. The complex interplay of factors comprising the cultural context, all of which must be addressed and somehow compensated is a major hurdle to overcome. However, theoretical modeling can help tackle such problems, as O'Connor (1992: 106) explains...

> We bring our individual preconceptions to the recording and interpretation of bone assemblages, and those preconceptions are often implicit and poorly articulated. Replacing those preconceptions with explicit models would not bring absolute truth, which...is probably unattainable. Instead it would force us to examine familiar data in different ways, perhaps thereby throwing some new light on this particularly difficult and fascinating topic.

While it is easy to advocate the use of models, creating them is a different story. We must consider that a number of factors influence economic and dietary decisions. Different social classes, genders, age brackets, and ideological affiliations often consume different resources for a variety of reasons. Moreover, there is much regional diversity to diets, itself the product of varying cultural and natural circumstances. Constructing a model which can test all of these complex variables is certainly a formidable task. Until such a "super model" can be formulated (if ever) we might better concentrate our efforts on some of the key influences affecting production and consumption. Whittaker (1995), for example, calls for a shift from the traditional theoretical perspective which stresses the urban-rural dichotomy in antiquity to one where the two regions are integrated. He proposes that we strive to "understand urban-rural as a dramatic representations of more fundamental social relations" (Whittaker 1995: 10). Gumerman (1997) also stresses a need to examine the role of social relations in dietary studies of complex societies, while Meadows (1994, 1997) examines the social context for food consumption in Roman Britain through an integrated analysis of the full range of archaeological materials—animal bones, plant remains, ceramics, architecture, and so forth—associated with eating and drinking. In order to comprehend better the role of animals in Roman diet and economy, we must shift the focus away from ideographic interpretation of individual and isolated data-sets towards more systematic model building which examines multiple factors and incorporates data from not only a variety of sites, but also a variety of disciplines.

Lastly, I would like to conclude with a quotation.

> I believe archaeology would benefit from more of its scientists being more adventurous and addressing large culture historical questions through their own specialism. (Jones 1991: 8)

Although relatively simple and perhaps obvious to many, there is great significance in this statement. In some manner, Jones' plea for "more adventurous" research has been the impetus for this thesis on mammalian production and consumption in Roman Italy. While my integrated analysis of zooarchaeological and textual data makes a contribution to our understanding of the vast and complicated aspects which characterize the ancient diet and economy, it also raises a host of questions and future issues to pursue. Such is the limitless nature of any interdisciplinary research. If I have convinced people to consider the value of animal bones in our reconstruction of ancient Roman life, and to recognize the importance of integrating this material with other sources of data then I have achieved my principal goal.

TABLE 1

Author, work, and approximate date range for ancient texts consulted with relatively many references to animals.

Author	Work	Approximate date
2nd century BC		
Plautus	various comedies+	c. 250-c. 184 BC
Cato	*De agri cultura*	234-149 BC
1st century BC		
Lucretius	*De rerum natura*	98-c. 55 BC
Horace	*Epodes; Carmina* or *Odes; Satires; Epistulae*	65-8 BC
Propertius	*Elegies*	c. 50- after 16 BC
Strabo	*Geographica*	c. 7 BC
Varro	*De re rustica*	116-27 BC
Virgil	*Eclogues; Georgics*	37 BC; 29 BC
Tibullus	*Elegies*	55/48-19 BC
1st century AD		
Ovid	*Fasti*	43 BC- AD 17
Celsus	*Artes*	c. AD 14-37
Persius	*Satires*	AD 34-62
Calpurnius	*Eclogues*	c. AD 50-60
Columella	*De re rustica*	c. AD 60-65
Grattius	*Cynegetica*	Augustan period
Martial	*Epigrammata*	c. AD 40-103/104
Petronius	*Satyricon*	c. AD 60
Pliny the Elder	*Naturalis Historiae*	c. AD 77
2nd century AD		
Pliny the Younger	*Epistulae*	c. AD 61/62-111/113
Juvenal	*Satires*	c. AD 110-127
3rd century AD		
Aelian (or Aelianus)	*De natura animalium**	c. AD 170-c. 235
Nemesianus	*Cynegetica; Eclogues*	late 3rd century
4th century AD		
Palladius	*De re rustica* or *Opus agriculturae*	4th century AD
Vegetius	*De re militari*	late 4th century AD
Apicius	*De re coquinaria*	late 4th century AD
Codex Theodosianus	law code	4th-5th century AD
Novellae Valentinianae	law code	
5th century AD		
Justinianic Code	law code	5th century AD
Macrobius	*Saturnalia*	c. AD 400
6th/7th century AD		
Cassiodorus	*Variae epistulae*	c. AD 490-583

* indicates work first written in Greek
+ those with animal reference include *Aulularia, Captivi, Epidicus, Menaechmi, Mostellaria, Pseudolus, Trinummus*

TABLE 2

Author, work, and approximate date range for ancient texts consulted with relatively few references to animals.

Author	Work	Approximate date
3rd century BC		
Naevius	various plays	c. 270-c. 190 BC
2nd century BC		
Caecilius Statius	fragments from various plays	c. 223/222-c. 166 BC
Terence	*Eunuchus*	c. 195/185-159 BC
Polybius	*Historiae**	c. 220-118 BC
Lucilius	*Satires*	c. 180-102 BC
1st century BC		
Varro	*De lingua Latina; Saturae Menippeae*	116-27 BC
Catullus	*Carmina*	c. 84-c. 54 BC
Caesar	*Bellum Civile; Bellum Gallicum*	c. 50 BC
Cicero	*Epistulae ad familiares; De finibus; In Pisonem; De officiis; Pro Scauro; Pro Quinctio*	59-54BC; 44 BC
Sallust	*Historiae*	c. 39-35 BC
Dionysius Halicarnasseus	various works	c. 30 BC
1st century AD		
Livy	*Historiae; Epitomae*	c. 59 BC- AD 12 or 17
Persius	*Satires*	AD 34-62
Frontinus	*Strategemata*	c. AD 84
Josephus	*Bellum Iudaicum***; *Vita**	AD 37 or 38 - 94/95
2nd century AD		
Tacitus	*Historiae; Annales*	AD 106-107; c. AD 116
Suetonius	*De Vita Caesarum*	c. AD 70-c. 140
Fronto	*Epistulae*	c. AD 100-166
Aulus Gellius	*Noctes Atticae*	c. AD 130-180
3rd century AD		
Tertullian	*De testimonio animae; De spectulis; Ad nationes*	c. AD 160-c. 225
Cassius Dio	*Historiae Romanae**	AD 150-235
Arnobius	*Adversus nationes*	c. AD 295
4th century AD		
Ammianus Marcellinus	*Rerum Gestarum Libri*	c. AD 325/350-395
5th century AD		
Sidonius Apollinaris	*Epistulae, Carmina*	c. 430 - c. 480
6th/7th century AD		
Isidorus	*Origines, Etymologiae*	AD 602-636

* indicates work first written in Greek ** first written in Aramaic

TABLE 3

Southern Italy: Republican period sites.

Site	Site type	Dates	Locality	Reference
Kaulonia	u1: Iron Age and Hellenistic city	6th - 3rd BC	Ionian coast, Calabria	Columeau 1989
Otranto	u1: Iron Age city	6th BC	Adriatic coast, Apulia	Bigini 1983
Roccagloriosa	u2/sp: Lucanian settlement and sanctuary	4th - 3rd BC	southern Campania, near coast	Bökönyi 1990, 1993a&b; Assad n.d.
Cozzo Presepe	u2: rural fortification	4th - 3rd BC	Basilicata, inland	Watson 1977
Metaponto territory	u2: settlement and sanctuary	8th BC - 1st AD	Ionian coast, Basilicata	Cabaniss 1983
Monte Irsi	r: rural fortification	4th - 1st BC	Basilicata, inland	Barker 1977a
Gravina	r: Hellenistic and Roman villa	7th BC - 1st AD	Puglia, inland	Watson 1992; MacKinnon 1994 & in progress
Vaste, Fondo San Antonio	r/sp: Hellenistic and Roman cistern fill	mid 3rd - 2nd BC	Puglia, near coast	Albarella 1995
Locri	sp: settlement, and bothroi	7th - 2nd BC; bothroi: 6th - 5th BC	Ionian coast, Calabria	D'Errico and Moigne 1985; Lissi et al. 1958
Hipponion-Vibo Valentia	sp: animal burials	2nd BC	southern Calabria, near coast	Albarella 1989
Capaccio	sp: bothroi	Hellenistic	southern Campania, near coast	Zancani Montuoro and Zanotti-Bianco 1937
Naniglio	sp: well deposit	Hellenistic	southern Campania	Albarella, n.d.
Gravetta	sp: sanctuary	4th - 3rd BC	Basilicata, inland	Sublimi Saponetti 1991

r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special; n.d. = no date

TABLE 4

Southern Italy: Imperial and Late Antiquity sites.

Site	Site type	Dates	Locality	Reference
Otranto	u1: Roman and Medieval city	30 BC - 15th AD	Adriatic coast, southern Apulia	Cartlege, Clark and Higgins 1992
San Giovanni	r: Roman rural villa	1st AD - 6th AD	Basilicata, inland	MacKinnon, in press
San Biagio	r: Roman rural villa	3rd - 4th AD	Metaponto area, southern Basilicata	Scali 1983
Oppido Lucano	r: Roman rural villa	1st BC - 6th AD	Basilicata, inland	Bökönyi 1994

r = rural; u1 = urban1 (i.e., city)

TABLE 5

Central Italy: Republican period sites.

Site	Site type	Dates	Locality	Reference
Pompeii, forum area	u1: urban settlement	6th BC - early 1st AD	southern Campania, coastal	King 1985, 1994, n.d.3
Pompeii, Casa di Ganimede	u1: urban settlement	6th BC	southern Campania, coastal	Kokabi 1982
Pompeii 94 & Pompeii 95	u1: urban settlement	Republican	southern Campania, coastal	Richardson 1994, 1995; Richardson et al. 1997
Carminiello, Naples	u1: urban settlement	1st BC - 1st AD	southern Campania, coastal	King 1994
Ostia, castrum	u1: urban settlement	3rd - 1st BC	Latium, coastal	King 1985, n.d.4
Populonia	u1: urban settlement	3rd BC	north Etruria, near coast	De Grossi Mazzorin 1985
San Omobono, Rome	u1/sp: urban temple, ritual deposit	6th - 5th BC	Rome	Tagliacozzo 1989
Narce	r: rural complex	4th - 2nd BC	Etruria, inland	Barker 1976
Settefinestre	r: rural villa	late 1st BC - early 1st AD	south Etruria, near coast	King 1985
Ossaia, Cortona	r: rural villa	2nd BC - early 1st AD	central Etruria, inland	MacKinnon, in progress
Via Gabina, site 11	r: suburban villa	3rd BC - 3rd AD	Latium, inland	Clark, n.d.
San Giovenale	r/sp: rural villa and sanctuary	3rd - 1st BC	Etruria	Sorrentino 1981a, 1981b

r = rural; u1 = urban1 (i.e., city); sp = special; n.d. = no date

TABLE 6

Central Italy: Imperial period sites.

Site	Site type	Dates	Locality	Reference
Saepinum	u1: urban settlement	c. 2nd - 3rd AD	Molise, inland	Barker and Clark 1995
Ostia, castrum	u1: urban settlement	1st - 5th AD	Latium, coast	King 1985, n.d.4
Ostia, bath	u1: urban settlement	1st - mid 3rd AD	Latium, coast	IPU 1968, 1973, 1977
Pompeii, gardens	u1: urban settlement	late 1st AD	Campania, coast	Jashemski 1973, 1979 &1993
Pompeii, Forum	u1: urban settlement	1st AD	Campania, coast	King 1985, 1994, n.d.3
Carminiello	u1: urban settlement	2nd - 4th AD	Campania, coast	King 1994
Naples, Santa Sofia	u1: urban settlement	early 1st AD	Campania, coast	King, n.d.5
Capua, Carillo	u1: urban settlement	2nd - 3rd AD	Campania, coast	King 1987b
Pistoia	u1: urban settlement	1st - 3rd AD	northern Etruria, inland	Giorgetti and Campodoni 1985
Luni	u1: urban settlement	3rd AD	Liguria, near coast	Barker 1977b
Cosa lagoon	u1: port settlement	1st - 2nd AD?	south Etruria, coastal	Hesse and Wapnish 1987
Monte Gelato	r: rural complex (vicus/villa?)	1st - 2nd AD	south Etruria, inland	King 1997
Quintili	r: suburban rural	1st - 2nd AD	Latium, inland	De Grossi Mazzorin 1987
Via Gabina site 11	r: suburban villa	3rd BC - 3rd AD	Latium, inland	Clark, n.d.
Ossaia, Cortona	r: rural villa	1st - 2nd AD	central Etruria, inland	Bökönyi, n.d.; MacKinnon, in progress
San Potito	r: rural villa	Imperial period	Abruzzo, inland	Bökönyi 1986
Lugnano	r: rural villa	1st - 3rd AD	Umbria, inland	MacKinnon 1998
Matrice	r: rural villa	1st - 3rd AD	Molise, inland	Barker and Clark 1995; Clark, forthcoming
Le Colonne	r: rural villa	1st BC - 2nd AD	south Etruria, near coast	King 1985, n.d.1
Settefinestre	r: rural villa	late 1st - 3rd AD	south Etruria, near coast	King 1985
Forum Transitorium, Rome	u1/sp: urban deposit, ritual?	1st AD	Rome, inland	De Grossi Mazzorin 1989
San Costanzo	sp: sanctuary, church	c. 3rd/4th AD	Island of Capri, Bay of Naples	Albarella 1992
Cantone	sp: necropolis	1st BC - 1st AD	Abruzzo, inland	Sorrentino 1989

r = rural; u1 = urban1 (i.e., city); sp = special; n.d. = no date

TABLE 7

Central Italy: Late Antiquity sites.

Site	Site type	Dates	Locality	Reference
Rome, Schola Praeconum	u1: urban settlement	5th AD	Palatine Hill, Rome	Barker 1982
Rome, Meta Sudans	u1: urban settlement	5th-6th AD	near Flavian amphitheatre	De Grossi Mazzorin 1995
Ostia, bath	u1: urban settlement	late 3rd - 5th AD	Latium, coastal	IPU 1968, 1973, 1977
Carminiello	u1: urban settlement	mid 5th - 6th AD	Campania, coast	King 1994
Capua, Carillo	u1: urban settlement	5th - 6th AD	Campania, coast	King 1987b
Naples, Via San Paolo	u1: urban settlement	5th - 6th AD	Campania, coast	Albarella 1988b
Naples, Santa Patrizia	u1: urban settlement	4th AD	Campania, coast	Albarella 1988a
Naples, Girolamini	u1: urban settlement	late 4th AD	Campania, coast	Albarella 1988a
Naples, Santa Maria la Nova	u1: urban settlement	6th AD	Campania, coast	King, n.d.2
Pistoia	u1: urban settlement	4th - 7th AD	northern Etruria, inland	Giorgetti and Campodoni 1985
Luni	u1: urban settlement	4th - 8th AD	Liguria, near coast	Barker 1977
Via Gabina site 10	r: suburban grain storehouse	Late Antiquity	Latium, inland	Clark, n.d.
Settefinestre	r: rural villa	Late Antiquity	Etruria, near coast	King 1985
Monte Gelato	r: rural villa	4th - 5th AD	south Etruria, inland	King 1997
Matrice	r: rural villa	4th - 5th AD	Molise, inland	Barker and Clark 1995
San Giacomo	r: rural villa	early 5th AD	Molise, inland	Albarella 1993
Lugnano	r/sp: rural villa / infant cemetery	5th AD	Umbria, inland	MacKinnon 1998
Campochiaro	sp: sanctuary	4th - 5th AD	Molise, inland	Barker and Clark 1995

r = rural; u1 = urban1 (i.e., city); sp = special; n.d. = no date

TABLE 8

Northern Italy: Republican period sites.

Site	Site type	Dates	Locality	Reference
Spina	u1: Greek-Etruscan city	6th - 4th BC	Emilia Romagna, coastal	Riedel 1978
Colognola	u2: settlement	4th - 2nd BC	near Verona, inland	Riedel 1984a
Pozzuolo del Friuli	u2: settlement	1st BC - 1st AD	Friuli, near coast	Riedel 1983-84
Montereale	sp: ritual deposit	late 2nd - early 1st BC	Friuli-Venezia	Petrucci and Vitri 1995

u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special; n.d. = no date

TABLE 9

Northern Italy: Imperial period sites.

Site	Site type	Dates	Locality	Reference
Modena	u1: urban settlement	late 1st BC - 1st AD	Emilia-Romagna, inland	De Grossi Mazzorin 1988
Palazzo Dugentesco	u2: settlement	1st - 3rd AD	Piedmonte, inland	D'Errico and Giacobini 1984
Invillino-Ibligo	u2: settlement	1st - 7th AD	Friuli, inland	Storck and von den Driesch 1987
Innichen	u2: settlement	2nd - 5th AD	South Tyrol, Trentino, inland	Riedel 1983
Stufels - Hotel Dominik	u2: settlement	1st - 5th AD	South Tyrol, Trentino, inland	Riedel 1979b, 1984b
Stufels - Senoner	u2: settlement	2nd - early 4th AD	South Tyrol, Trentino, inland	Riedel 1979b, 1984b
Torcello	u2: settlement	1st - 4th AD	Venice coast	Riedel 1979c
Volano	sp: agriculture/ craft production deposit	late 3rd - early 4th	Trentino, inland	Riedel and Scarpa 1988
Aquileia	sp: cattle horn core deposit	Imperial	Friuli, coast	Riedel 1979a

u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

TABLE 10

Northern Italy: Late Antiquity sites.

Site	Site type	Dates	Locality	Reference
Altino	u1: urban settlement	Late Antiquity	Venice coast	Riedel 1985
Imola, Villa Clelia	u2: suburban complex, church	5th - 6th AD	near Bologna, inland	Farello 1990b
Udine	u2: settlement	late 4th - late 6th AD	Friuli, inalnd	Riedel 1990
Invillino-Ibligo	u2: settlement	mid 4th - mid 7th AD	Friuli, inland	Storck and von den Driesch 1987
Monte Barro	r: rural villa	4th - 7th AD	Lombardia, inland	Baker 1991
Lomello	r: rural villa	Late Antiquity	near Pavia, inland	King 1987a
Classe	sp: dog burials	Late Antiquity	near Pordenone, inland Veneto	Farello 1995
Volaho	sp: agriculture/ craft production deposit	late 4th - early 5th	Trentino, inland	Riedel and Scarpa 1988

r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special; n.d. = no date

TABLE 11

Details on screening, preservation conditions, and carnivore gnawing amongst Roman period sites in Italy.

SITE	R	P	T	Screening	Preservation	Carnivore gnawing	Notes
Gravina, pit	S	1	r	most	good	none	
Gravina	S	1	r	some	fair	little	
Gravina, villa	S	1	r	some	fair	little	cistern deposit sieved
Monte Irsi	S	1	r	none	good	na	
Vaste	S	1	r/sp	none	good	none	
Naniglio	S	1	sp	most	good	none	
Roccagloriosa, votive	S	1	sp	none	poor	na	clay soil
Locri	S	1	sp	na	fair	some	
Hipponion-Vibo Valentia	S	1	sp	na	good	na	buried quickly
Cozzo Presepe	S	1	u2	some	fair	na	some wet sieved
Roccagloriosa	S	1	u2	none	poor	na	clay soil
Metaponto, kiln	S	1	u2	na	na	little	
San Giovanni	S	2	r	little	good	some	
San Giovanni	S	3	r	some	good	some	
Otranto	S	3	u1	none	na	na	
Narce	C	1	r	some	good	na	extremely fragmented
San Giovenale	C	1	r	na	na	na	fragmented
Ossaia, Cortona	C	1,2	r	none	fair	some	acidic soil
Via Gabina, site 11	C	1,2	r	na (likely some)	fairly good	little	weathering minimal
Settefinestre	C	1,2,3	r	some	fair	na	
San Giovenale, cult	C	1	sp	na	na	na	fragmented
Pompeii 95	C	1	u1	most	poor	na	highly fragmented
Pompeii 94	C	1	u1	na	good	na	
Populonia	C	1	u1	na	good	na	fragmented
Carminiello	C	1,2,3	u1	some	good	na	vigilant trench recovery
San Costanzo	C	2	r	most	good	na	
Quintili	C	2	r	most	na	na	majority sieved
San Potito	C	2	r	na	poor	na	
Lugnano, villa	C	2,3	r	little	fair	some	
Monte Gelato	C	2,3	r	none	good	some	careful collection
Matrice	C	2,3	r	na	good	na	few show exposure
Cantone	C	2	sp	most	na	na	
Forum Transitorium	C	2	u1	na	good	na	fragmentary
Cosa lagoon	C	2	u1	na	good	none	buried quickly
Ostia, bath	C	2,3	u1	na	fair	na	quite fragmentary
Luni	C	2,3	u1	some	na	na	careful collection
Lugnano, cemetery	C	3	r	most	good	limited	
San Giacomo	C	3	r	none	good	little	

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

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TABLE 11 (continued)

Details on screening, preservation conditions, and carnivore gnawing amongst Roman period sites in Italy.

SITE	R	P	T	Screening	Preservation	Carnivore gnawing	Notes
Via Gabina, site 10	C	3	r	na (likely some)	fairly good	little	weathering minimal
Campochiaro	C	3	sp	most	fair	na	very fragmented
Naples, S. Patrizia	C	3	u1	most	fair	na	some wet sieved
Naples, Via San Paolo	C	3	u1	little	fair	na	
Naples, Girolamini	C	3	u1	none	fair	na	
Rome, Meta Sudans	C	3	u1	most	na	na	wet-sieved
Spina	N	1	u1	na	good	na	
Pozzuolo del Friuli	N	1	u2	none	fair	na	highly fragmented
Modena	N	2	u1	na	good	na	
Torcello	N	2	u2	some	na	na	
Palazzo Dugentesco	N	2	u2	na	fair	some	fragmentary
Invillino	N	2,3	u2	na (likely none)	na	na	fragmentary
Monte Barro	N	3	r	some	good	na	many fragments
Lomello	N	3	r	some	poor	some	parts of layers sieved
Classe	N	3	sp	most	good	none	humid anaerobic environment
Villa Clelia	N	3	u2	na	na	na	many fragments

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

TABLE 12

Number of teeth, NISP, and #teeth/NISP figures for Roman period sites in Italy.

SITE	R	P	T	# teeth*	NISP*	#teeth/NISP x100	Screening
San Giovanni	S	3	r	8068	10059	80.4	most
San Costanzo	C	2	r	20	28	71.4	most
Lugnano, villa	C	3	r	19	27	70.4	little
Lugnano, cemetery	C	3	r	283	405	69.9	most
San Giovanni	S	2	r	88	158	55.7	little
Via Gabina, site 11	C	1,2	r	42	76	55.3	na (likely some)
Lomello	N	3	r	112	253	44.3	some
Stufels - Senoner	N	2	u2	310	786	39.4	na
Campochiaro	C	3	sp	231	593	39.0	most
Settefinestre	C	1	r	66	175	37.7	some
Settefinestre	C	2	r	837	2237	37.4	some
Settefinestre	C	3	r	274	757	36.2	some
San Giacomo	C	3	r	65	205	31.7	none
Locri	S	1	sp	100	325	30.8	na
Naples, Via San Paolo	C	3	u1	49	162	30.2	na
Naples, Girolamini	C	3	u1	216	726	29.8	none
Monte Gelato	C	2	r	85	294	28.9	some
Naples, Santa Patrizia	C	3	u1	150	538	27.9	most
San Giovenale	C	1	r	13	47	27.7	na
Carminiello	C	2	u1	58	234	24.8	some
Pozzuolo del Friuli	N	1	u2	62	252	24.6	none
Colognola	N	1	u2	373	1593	23.4	na
Invillino	N	2,3	u2	4402	18821	23.4	na (likely none)
Schola Praeconum	C	3	u1	360	1568	23.0	na
Gravetta	S	1	sp	11	48	22.9	na
Carminiello	C	3	u1	476	2087	22.8	some
Torcello	N	2	u2	16	71	22.5	some
Narce	C	1	r	17	77	22.1	some
Matrice	C	3	r	177	816	21.7	na
Via Gabina, site 10	C	3	r	274	1266	21.6	na (likely some)
Monte Barro	N	3	r	197	968	20.4	some
San Giovenale, cult	C	1	sp	7	36	19.4	na
Monte Gelato	C	3	r	93	483	19.3	none
Lugnano, villa	C	2	r	4	21	19.0	little
Gravina, pit	S	1	r	53	290	18.3	most
Matrice	C	2	r	118	656	18.0	na
Carminiello	C	1	u1	18	103	17.5	some
Altino	N	3	u1	83	477	17.4	na
Volano	N	3	sp	34	199	17.1	na
Stufels - Hotel	N	2	u2	130	907	14.3	na
Luni	C	2	u1	15	106	14.2	some
Otranto	S	3	u1	49	361	13.6	none
Innichen	N	2	u2	76	563	13.5	na
Modena	N	2	u1	162	1242	13.0	na
Saepinum	C	2	u1	5	39	12.8	na
Luni	C	3	u1	65	539	12.1	some
Pompeii, Ganimede	C	1	u1	61	554	11.0	na
Monte Irsi	S	1	r	17	157	10.8	none
Populonia	C	1	u2	176	1988	8.9	na
Forum Transitorium	C	2	u1	6	72	8.3	na
Volano	N	2	sp	6	80	7.5	na
Montereale	N	2	sp	78	1157	6.7	na
Villa Clelia	N	3	u2	1	20	5.0	na
Roccagloriosa, votive	S	1	sp	1	55	1.8	none

R = geographic region: S = southern Italy; C =c entral Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special
na = data not available
* = combined values for cattle + sheep/goat + pig

TABLE 13

Total sample, NISP sample, and NISP values for animal taxa from Roman period sites in Italy, in descending order of NISP sample.

Site	R	P	T	Total Sample	NISP Sample	NISP mammal	NISP bird	NISP fish	NISP reptile	NISP amphian
Invillino-Ibligo	N	2,3	u2	26601	22853	22204	642	7	0	0
San Giovanni	S	2,3	r	40000+	13359	10941	c.2418	64	16	16
Carminiello	C	3	u1	5858+	3390	2378	990	22	0	0
Settefinestre	C	2	r	6742	3031	2628	335	37	29	2
Rome, Meta Sudans	C	3	u1	2826+	2826+	2451	320	47	8	0
Pompeii, forum	C	1	u1	2686+	2686+	2686+	na	na	na	na
Ostia, bath	C	2	u1	2599+	2599+	2566	29	3	1	0
San Omobono	C	1	u1/sp	2096+	2096	2080	9	5	1	1
Populonia	C	1	u1	8080	2054	2014	23	13	4	0
Via Gabina, site 10	C	3	r	4495	2042	1815	213	9	5	0
Colognola	N	1	u2	5453	2029	2018	10	1	0	0
Montereale	N	3	sp	3132	1810	1164	646	0	0	0
Roccagloriosa	S	1	u2	c.5000	1799	1787	8	0	4	0
Schola Praeconum	C	3	u1	c.4000	1746	1614	132	5	0	0
Stufels - Senoner	N	2	u2	5288	1731	1551	c.180	0	0	0
Cantone	C	2	sp	1607+	1607	824	507	276	0	0
Monte Barro	N	3	r	5345	1506	1300	116	96	0	4
Ossaia, Cortona	C	2	r	4500+	c.1500	na	na	na	na	na
Gravina (MacKinnon, in progress)	S	1	r	1439+	1439	1299	28	na	72	40
Modena	N	2	u1	4369	1417	1328	83	6	0	0
Stufels - Hotel	N	2	u2	2632	1235	1155	c.80	0	0	0
Udine	N	3	u2	1056+	1056+	1056+	na	na	na	na
Lugnano, cemetery	C	3	sp	2467	1026	822	177	1	0	26
Settefinestre	C	3	r	2023	1015	910	20	1	83	1
Ossaia, Cortona	C	1	r	na	c.1000	na	na	na	na	na
Pompeii, Ganimede	C	1	u1	1038	936	909	16	11	0	0
Matrice	C	3	r	2019+	894+	894	na	na	na	na
Kaulonia	S	1	u1	759+	759	751	5	1	2	0
Gravina (Watson 1992)	S	1	r	757+	757+	757	na	na	na	na
Naples, Girolamini	C	3	u1	1638	743	741	1	0	1	0
Innichen	N	2	u2	1770	740	740	0	0	0	0
Altino	N	3	u1	1488	732	732	0	0	0	0
Matrice	C	2	r	1466	689+	689	na	na	na	na

R= Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
"+" indicates lowest possible recorded value; actual value may be greater; na = data not available

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TABLE 13 (continued)

Total sample, NISP sample, and NISP values for animal taxa from Roman period sites in Italy, in descending order of NISP sample.

Site	R	P	T	Total Sample	NISP Sample	NISP mammal	NISP bird	NISP fish	NISP reptile	NISP amphian
Campochiaro	C	3	sp	3155+	676+	652	24	na	2	na
Otranto	S	3	u1	1774+	644+	602	39	3+	0	0
Naples, S. Patrizia	C	3	u1	1416	607	560	30	16	0	1
Aquileia	N	2	sp	601+	601+	601+	na	na	na	na
Luni	C	3	u1	895	577	547	30	0	0	0
Le Colonne	C	2	r	966	547	547	0	0	0	0
Monte Gelato	C	2	r	914+	539	532	na	na	0	7
Pompeii, Forum	C	2	u1	503+	503+	503+	na	na	na	na
Monte Gelato	C	3	r	861+	498	496	na	na	1	1
Metaponto area, kiln	S	1	u2	495+	495	493	2	0	0	0
San Giacomo	C	3	r	563	462	436	24	0	0	2
Oppido Lucano	S	2	r	451+	451	432	10	0	9	0
Gravina, pit	S	1	r	1853	440	316	23	13	88	0
Locri	S	1	sp	397+	397	397	na	na	na	na
Lomello	N	3	r	570+	368	254	10	22	0	82
Metaponto area, Pizz.	S	1	u2	365+	365	356	3	0	4	2
Cozzo Presepe	S	1	u2	7376+	344+	344+	na	na	na	na
San Potito	C	2	r	c.500	315	311	4	0	0	0
Otranto	S	1	u1	294+	294	267	1	0	26	0
Pozzuolo del Friuli	N	1	u2	974	277	276	1	0	0	0
Vaste	S	1	r/sp	312+	274	208	1	0	65	0
San Biego	S	2,3	r	266+	266	236	25	0	5	0
Pistoia	C	3	u1	1812	258	244	14	0	0	0
Pompeii 95	C	1	u1	1853	253	148	12	93	0	0
Settefinestre	C	1	r	544	241	230	8	0	3	0
Carminiello	C	1	u1	474+	241	236	5	0	0	0
Quintili	C	2	r	493	225	157	61	7	0	0
Volano	N	3	sp	218+	218	218	0	0	0	0
Pompeii, gardens	C	2	u1	297	207	205	2	na	na	na
Naples, Via San Paolo	C	3	u1	173+	173	164	8	0	0	0
Ostia, bath	C	3	u1	171+	171+	151	c.20	0	0	0

R= Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
"+" indicates lowest possible recorded value; actual value may be greater; na = data not available

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TABLE 13 (continued)

Total sample, NISP sample, and NISP values for animal taxa from Roman period sites in Italy, in descending order of NISP sample.

Site	R	P	T	Total Sample	NISP Sample	NISP mammal	NISP bird	NISP fish	NISP reptile	NISP amphian
Monte Irsi	S	1	r	c.400	165	162	2	0	1	0
Carminiello	C	2	u1	282+	142	110	32	0	0	0
Hipponion-Vibo Valentia	C	1	sp	321	133	133	0	0	0	0
Via Gabina, site 11	C	2,3	r	262	126	107	14	1	4	0
Ostia, castrum	C	2	u1	125+	125+	125	na	na	na	na
Luni	C	2	u1	180	114	107	7	0	0	0
San Costanzo	C	2	r	109+	109	70	11	27	0	1
Ostia, castrum	C	1	u1	107+	107+	107	na	na	na	na
Volano	N	2	sp	106+	106	106	0	0	0	0
Naniglio	S	1	sp	124	105	104	0	0	0	1
Gravetta	S	1	sp	103+	103	99	0	0	4	0
Naples, Santa Maria la Nova	C	3	u1	179	98	74	15	7	2	0
Narce	C	1	r	138	87	87	0	0	0	0
Torcello	N	2	u2	156	76	76	0	0	0	0
Forum Transitorium	C	2	u1	129	73	72	1	0	0	0
Roccagloriosa, votive	S	1	sp	62+	62	62	0	0	0	0
San Giovenale	C	1	r	166	61	52	9	0	0	0
Capua, Carillo	C	2	u1	132	57	46	0	11	0	0
Lugnano, villa	C	3	r	144	56	39	17	0	0	0
Palazzo Dugentesco	N	2	u2	50+	50	44	6	0	0	0
Capacci	S	1	sp	48+	48+	46+	2	0	0	0
Naples, Santa Sofia	C	2	u1	46+	46+	46	na	na	na	na
Lugnano, villa	C	2	r	134	45	41	4	0	0	0
Villa Clelia	N	3	u2	137	44	25	3	16	0	0
Capua, Carillo	C	3	u1	58	42	42	0	0	0	0
Saepinum	C	2	u1	87+	39+	39	na	0	na	na
San Giovenale, cult	C	1	sp	135	39	39	0	0	0	0
Cosa lagoon	C	2	u1	45	38	27	1	0	10	0
Pistoia	C	2	u1	250	30	26	4	0	0	0
Spina	N	1	u1	10000+	na	na	na	na	na	na
Pompeii 94	C	1	u1	1420	na	na	na	na	na	na
Classe	N	3	sp	100+	na	na	na	na	na	na

R= Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
"+" indicates lowest possible recorded value; actual value may be greater; na = data not available

TABLE 14

Frequency of mammalian taxa represented from faunal deposits amongst four categories of Roman period sites in Italy.

TAXON	% rural sites n=29	% urban 1 sites n=37	% urban 2 sites n=15	% special sites n=16
DOMESTIC	**100.0**	**100.0**	**100.0**	**100.0**
cattle	93.1	100.0	100.0	75.0
sheep/goat	100.0	100.0	100.0	81.3
sheep	58.6	40.5	60.0	31.3
goat	62.1	32.4	60.0	37.5
pig	100.0	100.0	100.0	75.0
equid	82.8	70.3	73.3	62.5
horse	58.6	59.5	60.0	43.8
donkey	13.8	18.9	20.0	18.8
mule	3.3	2.7	0.0	12.5
dog	79.3	70.3	53.3	62.5
cat	24.1	27.0	6.7	6.3
camel	3.4	0.0	0.0	0.0
WILD	**79.3**	**51.4**	**73.3**	**43.8**
red deer	65.5	29.7	66.7	31.3
roe deer	48.3	16.2	13.3	12.5
fallow deer	31.0	8.1	6.7	0.0
wild boar	31.0	16.2	40.0	0.0
lagomorph	44.8	32.4	40.0	12.5
hare	41.4	24.3	40.0	18.8
rabbit	13.8	2.7	6.7	6.3
wolf	3.4	0.0	13.3	0.0
fox	10.3	13.5	40.0	6.3
brown bear	6.9	2.7	6.7	6.3
aurpch	6.9	0.0	6.7	0.0
wild goat	3.4	0.0	6.7	0.0
leopard	0.0	2.7	0.0	0.0
weasel/polecat	6.9	8.1	6.7	0.0
marten	6.9	2.7	6.7	0.0
badger	10.3	2.7	20.0	0.0
porcupine	3.4	0.0	0.0	0.0
hedgehog	6.9	2.7	0.0	0.0
otter	0.0	2.7	0.0	0.0
bat	6.9	0.0	0.0	0.0
RODENTS	**51.7**	**13.5**	**20.0**	**25.0**
mouse	24.1	5.4	13.3	18.8
dormouse	13.8	5.4	0.0	6.3
rat	31.0	10.8	6.7	0.0
vole	17.2	5.4	6.7	12.5
mole	0.0	0.0	6.7	0.0
beaver	0.0	2.7	6.7	0.0

TABLE 15

Mean NS/NISP ratios according to geographic region, temporal period, and site type groupings. Data derive from Appendix 2.

Region	**Period**	**Site Type**			
		Rural	**Urban 1**	**Urban 2**	**Special**
South	1	0.023 (n=4)	0.014 (n=2)	0.015 (n=3)	0.025 (n=2)
	2	0.020 (n=3)			
	3	0.018 (n=2)	0.024 (n=1)		
Central	1	0.004 (n=1)	0.005 (n=4)		0.002 (n=1)
	2	0.019 (n=5)	0.014 (n=2)		0.004 (n=1)
	3	0.023 (n=5)	0.009 (n=7)		0.013 (n=2)
North	1			0.014 (n=2)	0.003 (n=1)
	2		0.005 (n=1)	0.009 (n=3)	0.023 (n=1)
	3	0.010 (n=2)	0.007 (n=1)	0.001 (n=1)	

TABLE 16

NISP frequencies for mammalian taxa among sites in Roman Italy.

Site	R	P	T	NISP mammal	% cattle	% sheep /goat	% pig	% equid	% dog	% cat	% wild	% rodent
Gravina (7th-2nd BC)	S	1	r	107	18.7	51.0	19.6	0.0	3.7	0.0	7.0	0.0
Gravina (2nd BC-1st AD)	S	1	r	657	18.3	49.3	16.9	2.3	1.8	0.0	11.4	0.0
Gravina pit	S	1	r	316	2.2	67.4	22.2	0.0	1.3	0.0	7.0	0.0
Monte Irsi (3rd-2nd BC)	S	1	r	117	27.3	46.2	23.0	2.6	0.0	0.0	0.9	0.0
Monte Irsi (1st BC)	S	1	r	45	28.9	31.1	37.8	2.2	0.0	0.0	0.0	0.0
Vaste (Hellenistic)	S	1	r/sp	147	1.4	1.4	97.2	0.0	0.0	0.0	0.0	0.0
Vaste (Republican)	S	1	r/sp	60	5.0	16.7	53.3	21.7	1.7	0.0	1.7	0.0
Locri	S	1	sp	397	29.0	37.0	28.2	1.5	3.5	0.0	0.7	0.0
Naniglio	S	1	sp	104	0.0	0.0	0.0	2.9	97.1	0.0	0.0	0.0
Gravetta	S	1	sp	99	21.2	20.2	7.1	4.0	39.4	0.0	8.1	0.0
Roccagloriosa, votive	S	1	sp	62	0.0	98.4	1.6	0.0	0.0	0.0	0.0	0.0
Capaccio	S	1	sp	46+	0.0	38.3	0.0	0.0	31.9	29.8	0.0	0.0
Gravina, tomb	S	1	sp	34	11.8	5.9	2.9	0.0	76.5	0.0	2.9	0.0
Hipponion-Vibo Valentia	S	1	sp	133	0.0	0.0	0.0	14.5	85.5	0.0	0.0	0.0
Roccagloriosa	S	1	u2	1787	34.2	45.5	15.8	1.5	1.3	0.0	1.6	0.0
Kaulonia	S	1	u1	751	28.5	52.6	14.2	1.2	2.5	0.0	0.9	0.0
Metaponto, kiln	S	1	u2	493	37.3	20.1	8.3	13.4	11.6	0.0	9.3	0.0
Metaponto, Pizz.	S	1	u2	356	39.1	12.3	10.9	17.1	8.9	0.0	10.6	1.1
Cozzo Presepe	S	1	u2	344+	13.8	58.1	14.1	0.0	0.9	0.0	12.8	0.0
Otranto	S	1	u1	267	32.6	39.7	13.1	1.1	1.1	0.7	11.6	0.0
San Giovanni	S	2	r	178	9.0	19.1	60.6	0.6	3.4	0.0	3.9	3.4
Oppido Lucano	S	2	r	431	20.9	42.7	32.3	2.6	0.0	0.0	1.6	0.0
San Biago	S	2,3	r	236	9.3	50.9	37.8	0.8	0.4	0.0	0.4	0.4
San Giovanni	S	3	r	10763	6.1	15.5	70.4	1.8	0.5	0.1	2.0	3.6
Otranto	S	3	u1	602	23.4	21.1	15.4	0.7	32.4	0.0	7.0	0.0
Settefinestre	C	1	r	230	8.3	32.4	35.8	0.0	3.9	0.0	14.4	5.2
Narce	C	1	r	87	19.8	51.2	18.6	2.3	3.4	0.0	0.0	4.7
San Giovenale	C	1	r	52	9.6	21.1	59.6	1.9	0.0	0.0	7.7	0.0
San Giovenale, cult	C	1	sp	39	15.3	51.3	25.6	2.6	0.0	0.0	5.1	0.0
Pompeii, Forum	C	1	u1	2686+	19.0	22.3	54.4	0.4	1.9	0.2	0.7	1.1
San Omobono	C	1	u1/sp	2080	6.0	62.2	30.0	0.0	1.8	0.0	0.0	0.0
Pompeii, Ganimede	C	1	u1	909	31.5	45.0	22.9	0.2	0.1	0.0	0.3	0.0
Carminiello	C	1	u1	236	5.1	27.5	66.5	0.4	0.4	0.0	0.0	0.0
Pompeii 95	C	1	u1	148	3.4	44.6	51.4	0.0	0.7	0.0	0.0	0.0
Ostia, castrum	C	1	u1	107	11.2	1.9	84.1	2.8	0.0	0.0	0.0	0.0
Pompeii 94	C	1	u1	na	na	na	na	na	na	na	na	na
Populonia	C	1	u1	2014	10.2	42.4	46.1	0.1	0.0	0.0	1.2	0.0
Via Gabina, site 11	C	1,2	r	107	7.5	17.0	47.2	16.0	1.0	0.0	0.0	11.3
Settefinestre	C	2	r	2628	9.2	14.2	61.7	0.4	0.9	0.3	11.3	2.0
Le Colonne	C	2	r	547	21.0	26.7	45.2	2.4	0.2	0.0	4.6	0.0
Monte Gelato	C	2	r	532	3.8	12.0	39.5	0.2	43.4	0.0	1.1	0.0
Matrice (2nd-3rd AD)	C	2	r	417	9.1	28.5	56.8	0.2	0.2	0.2	5.0	0.0
San Potito	C	2	r	311	19.3	18.6	38.9	3.5	0.3	0.0	19.0	0.3
Matrice (1st AD)	C	2	r	272	20.2	32.0	44.1	0.4	0.7	0.0	2.5	0.0
Quintili	C	2	r	157	0.0	11.5	72.6	0.0	0.0	0.0	0.0	15.9
San Costanzo	C	2	r	47	0.0	12.8	46.8	0.0	0.0	0.0	0.0	40.4
Lugnano, villa	C	2	r	41	7.3	12.2	31.7	2.4	0.0	0.0	46.3	0.0
Cantone	C	2	sp	824	0.6	32.5	66.9	0.0	0.0	0.0	0.0	0.0
Ostia, bath	C	2	u1	2566	10.0	32.5	55.6	0.3	1.2	0.1	0.2	0.0
Pompeii, Forum	C	2	u1	504+	10.5	26.9	62.1	0.2	0.0	0.0	0.2	0.0
Pompeii, gardens	C	2	u1	205	30.7	17.1	39.0	3.9	7.3	1.4	0.5	0.0
Ostia, castrum	C	2	u1	125	0.8	26.4	68.8	4.0	0.0	0.0	0.0	0.0
Carminiello	C	2	u1	110	1.8	31.8	60.0	0.9	5.5	0.0	0.0	0.0
Forum Transitorium	C	2	u1	72	12.5	9.7	77.8	0.0	0.0	0.0	0.0	0.0

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special
na = data not available
"+" indicates lowest possible recorded value; actual value may be greater

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TABLE 16 (continued)

NISP frequencies for mammalian taxa among sites in Roman Italy.

Site	R	P	T	NISP mammal	% cattle	% sheep /goat	% pig	% equid	% dog	% cat	% wild	% rodent
Capua, Carillo	C	2	u1	46	6.5	28.3	60.9	0.0	4.3	0.0	0.0	0.0
Naples, Santa Sofia	C	2	u1	46	21.7	26.1	52.2	0.0	0.0	0.0	0.0	0.0
Saepinum	C	2	u1	39	15.4	46.1	38.5	0.0	0.0	0.0	0.0	0.0
Cosa lagoon	C	2	u1	27	32.1	7.1	10.7	10.7	39.3	0.0	0.0	0.0
Luni	C	2	u1	107	37.4	23.3	38.3	0.9	0.0	0.0	0.0	0.0
Pistoia	C	2	u1	25	40.0	12.0	48.0	0.0	0.0	0.0	0.0	0.0
Via Gabina, site 10	C	3	r	1815	10.3	21.6	40.2	2.7	13.5	0.1	3.1	8.5
Settefinestre	C	3	r	910	13.8	25.6	43.7	1.8	3.8	0.0	10.3	0.9
Matrice	C	3	r	894	10.2	35.1	46.2	2.7	0.3	3.9	1.5	0.0
Monte Gelato	C	3	r	486	5.4	35.5	56.5	0.2	1.0	0.0	0.6	0.8
San Giacomo	C	3	r	436	7.1	25.5	14.5	14.3	34.0	1.6	2.1	0.9
Lugnano, villa	C	3	r	39	7.7	15.4	46.2	7.7	17.8	0.0	2.6	2.6
Lugnano, cemetery	C	3	sp	822	5.7	9.7	33.8	2.4	42.2	0.0	1.8	4.3
Campochiaro	C	3	sp	652	17.3	33.4	40.2	0.0	0.2	0.0	5.2	3.7
Carminiello	C	3	u1	2378	7.6	47.9	32.3	0.2	3.7	5.9	0.4	2.0
Schola Praeconum	C	3	u1	1614	9.4	35.9	52.5	0.6	1.5	0.1	0.1	0.0
Naples, Girolamini	C	3	u1	741	6.6	35.2	57.2	0.1	0.1	0.0	0.8	0.0
Naples, S. Patrizia	C	3	u1	560	1.6	19.0	77.0	0.0	1.3	0.9	0.2	0.0
Naples, Via San Paolo	C	3	u1	164	17.0	30.7	45.5	1.1	5.1	0.6	0.0	0.0
Ostia, bath	C	3	u1	151	11.9	19.9	65.5	0.7	1.3	0.7	0.0	0.0
Naples, Santa Maria la Nova	C	3	u1	74	9.5	25.7	59.5	0.0	0.0	0.0	2.7	2.7
Capua, Carillo	C	3	u1	42	12.2	17.1	68.3	2.4	0.0	0.0	0.0	0.0
Luni	C	3	u1	547	20.8	38.0	39.7	0.7	0.2	0.0	0.4	0.2
Pistoia	C	3	u1	244	31.1	20.1	44.3	2.9	0.0	0.0	1.6	0.0
Rome, Meta Sudans	C	3	u1	2451	14.7	20.3	42.3	13.7	6.1	1.5	1.5	0.0
Spina	N	1	u1	na	20.0	15.0	50.0	1.5	2.0	0.0	11.5	0.0
Colognola	N	1	u2	2018	34.6	24.1	32.0	0.2	2.4	0.0	6.3	0.4
Pozzuolo del Friuli	N	1	u2	276	56.9	23.9	15.9	0.7	0.0	0.0	2.5	0.0
Montereale	N	1	sp	1164	0.5	46.2	53.2	0.0	0.0	0.0	0.1	0.0
Aquileia	N	2	sp	601+	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volano	N	2	sp	106	80.2	3.8	1.9	14.2	0.0	0.0	0.0	0.0
Modena	N	2	u1	1328	11.1	38.9	48.6	0.0	1.1	0.0	0.3	0.0
Stufels - Senoner	N	2	u2	1536	24.2	48.8	25.1	0.1	0.0	0.0	1.8	0.0
Stufels - Hotel	N	2	u2	1150	28.4	44.4	25.2	0.9	0.0	0.0	1.0	0.0
Innichen	N	2	u2	740	15.7	72.6	9.2	0.9	0.4	0.0	1.2	0.0
Torcello	N	2	u2	76	19.7	42.2	36.8	0.0	0.0	0.0	1.3	0.0
Palazzo Dugentesco	N	2	u2	44	20.5	45.5	31.8	0.0	0.0	0.0	2.3	0.0
Invillino TOTAL	N	2,3	u2	22204	24.2	43.0	30.3	0.9	0.1	0.0	1.5	0.1
Invillino	N	2,3	u2	4786	17.6	48.7	32.0	0.5	0.2	0.0	1.0	0.0
Invillino	N	3	u2	3430	27.1	39.3	30.6	0.9	0.0	0.0	2.2	0.0
Monte Barro	N	3	r	1300	11.0	28.7	57.2	0.1	0.0	0.0	2.9	0.1
Lomello	N	3	r	254	28.0	34.3	37.4	0.0	0.4	0.0	0.0	0.0
Volano	N	3	sp	218	92.7	1.4	1.4	4.0	0.5	0.0	0.0	0.0
Altino	N	3	u1	732	42.3	18.3	38.0	1.1	0.2	0.0	0.0	0.0
Udine	N	3	u2	1056+	na	na	na	na	na	na	na	na
Villa Clelia	N	3	u2	25	80.0	8.0	12.0	0.0	0.0	0.0	0.0	0.0

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special
na = data not available
"+" indicates lowest possible recorded value; actual value may be greater

TABLE 17

MNI frequencies for mammalian taxa at Roman period sites in Italy

Site	R	P	T	MNI mammal	% cattle	% sheep /goat	% pig	% equid	% dog	% cat	% wild	% rodent
Gravina, pit	S	1	r	19	5.2	52.6	21.1	0.0	5.3	0.0	15.8	0.0
Vaste (Hellenistic)	S	1	r/sp	11	9.1	18.2	72.7	0.0	0.0	0.0	0.0	0.0
Vaste (Republican)	S	1	r/sp	14	16.7	25.0	33.3	8.3	8.3	0.0	8.3	0.0
Capaccio	S	1	sp	14	0.0	28.6	0.0	0.0	14.3	21.4	0.0	35.7
Gravetta	S	1	sp	28	10.7	28.6	14.3	7.1	28.6	0.0	10.7	0.0
Locri	S	1	sp	37	18.9	37.8	21.6	2.7	10.8	0.0	8.1	0.0
Naniglio	S	1	sp	3	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0
Hipponion-Vibo Valentia	S	1	sp	4	0.0	0.0	0.0	25.0	75.0	0.0	0.0	0.0
Kaulonia	S	1	u1	329	30.1	42.9	21.3	1.2	3.3	0.0	1.2	0.0
Metaponto, kiln	S	1	u2	82	28.0	22.0	12.2	13.4	12.2	0.0	12.2	0.0
San Giovanni	S	2	r	20	10.0	30.0	35.0	5.0	5.0	0.0	10.0	5.0
San Giovanni	S	3	r	621	2.6	20.6	51.5	1.4	0.8	0.5	7.2	15.4
Otranto	S	3	u1	17	11.8	17.6	17.6	5.9	23.5	0.0	23.5	0.0
San Giovenale	C	1	r	14	21.5	21.5	35.7	7.1	0.0	0.0	14.2	0.0
Settefinestre	C	1	r	34	14.7	23.5	17.6	0.0	8.8	0.0	23.5	11.8
San Giovenale, cult	C	1	sp	7	14.3	28.6	28.6	14.3	0.0	0.0	14.3	0.0
Carminiello	C	1	u1	18	11.1	33.3	44.4	5.6	5.6	0.0	0.0	0.0
Pompeii 94	C	1	u1	na	19.8	11.6	33.7	19.8	15.1	0.0	0.0	0.0
Pompeii, Ganimede	C	1	u1	41	17.1	46.3	24.4	4.9	2.4	0.0	4.9	0.0
San Omobono	C	1	u1/sp	177	5.1	62.1	27.7	0.0	5.1	0.0	0.0	0.0
Populonia	C	1	u1	93	10.8	33.3	46.2	1.1	0.0	0.0	8.6	0.0
Via Gabina, site 11	C	1,2	r	10	10.0	20.0	40.0	20.0	10.0	0.0	0.0	0.0
Le Colonne	C	2	r	33	12.1	18.2	48.5	3.0	3.0	0.0	15.2	0.0
Lugnano, villa	C	2	r	11	9.1	27.3	27.3	9.1	0.0	0.0	27.3	0.0
Matrice (1st AD)	C	2	r	13	15.4	23.1	30.8	7.7	7.7	0.0	15.4	0.0
Matrice (2nd-3rd AD)	C	2	r	29	10.3	24.1	34.5	3.5	3.5	3.5	20.7	0.0
Monte Gelato	C	2	r	16	6.3	18.8	31.2	6.2	18.8	0.0	18.8	0.0
Quintili	C	2	r	21	0.0	23.8	47.6	0.0	0.0	0.0	0.0	28.6
Settefinestre	C	2	r	102	12.7	15.7	25.5	2.9	2.9	1.0	27.5	11.7
Cantone	C	2	sp	65	1.5	21.5	76.9	0.0	0.0	0.0	0.0	0.0
Capua, Carillo	C	2	u1	8	12.5	37.5	37.5	0.0	12.5	0.0	0.0	0.0
Carminiello	C	2	u1	8	12.5	25.0	37.5	12.5	12.5	0.0	0.0	0.0
Forum Transitorium	C	2	u1	10	10.0	20.0	70.0	0.0	0.0	0.0	0.0	0.0
Pistoia	C	2	u1	17	35.3	17.6	47.1	0.0	0.0	0.0	0.0	0.0
Lugnano, villa	C	3	r	12	8.3	16.7	41.7	8.3	8.3	0.0	8.3	8.3
Matrice	C	3	r	41	12.2	29.2	31.7	4.9	4.9	4.9	12.2	0.0
Monte Gelato	C	3	r	23	4.3	47.8	21.7	4.3	4.3	0.0	8.7	8.7
San Giacomo	C	3	r	29	10.3	24.1	24.1	13.8	6.9	3.4	13.8	3.4
Settefinestre	C	3	r	37	10.8	27.0	32.4	2.7	2.7	0.0	18.9	5.4
Via Gabina, site 10	C	3	r	49	14.3	24.5	26.5	6.1	14.3	2.0	10.2	2.0
Lugnano, cemetery	C	3	sp	70	2.9	10.0	38.6	4.3	18.6	0.0	10.0	15.7
Capua, Carillo	C	3	u1	6	16.7	33.3	33.3	16.7	0.0	0.0	0.0	0.0
Carminiello	C	3	u1	120	7.4	25.7	20.7	1.6	10.7	18.2	2.5	13.2

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special
na = data not available

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TABLE 17 (continued)

MNI frequencies for mammalian taxa at Roman period sites in Italy.

Site	R	P	T	MNI mammal	% cattle	% sheep /goat	% pig	% equid	% dog	% cat	% wild	% rodent
Naples, Girolamini	C	3	u1	23	8.7	30.4	47.9	4.3	4.3	0.0	4.3	0.0
Naples, S. Patrizia	C	3	u1	19	10.5	26.3	36.8	0.0	15.8	5.3	5.3	0.0
Naples, Santa Maria la Nova	C	3	u1	7	14.3	28.6	14.3	0.0	0.0	0.0	28.6	14.3
Naples, Via San Paolo	C	3	u1	35	22.9	25.7	34.3	2.9	11.4	2.9	0.0	0.0
Schola Praeconum	C	3	u1	53	11.3	32.1	45.3	1.9	5.7	1.9	1.9	0.0
Pistoia	C	3	u1	89	25.8	25.8	41.6	3.4	0.0	0.0	3.4	0.0
Rome, Meta Sudans	C	3	u1	132	18.2	16.7	26.5	15.1	10.6	5.3	7.6	0.0
Colognola	N	1	u2	101	15.8	30.7	29.7	3.0	5.0	0.0	12.9	3.0
Pozzuolo del Friuli	N	1	u2	20	30.0	25.0	30.0	5.0	0.0	0.0	10.0	0.0
Montereale	N	1	sp	44	4.5	29.5	63.6	0.0	0.0	0.0	2.3	0.0
Volano	N	2	sp	12	41.6	16.7	16.7	25.0	0.0	0.0	0.0	0.0
Modena	N	2	u1	75	9.3	46.7	37.4	0.0	2.6	0.0	3.9	0.0
Innichen	N	2	u2	32	18.8	34.4	21.9	9.4	3.1	0.0	12.5	0.0
Stufels - Hotel	N	2	u2	61	19.7	42.6	26.2	3.3	0.0	0.0	8.2	0.0
Stufels - Senoner	N	2	u2	51	25.5	33.3	27.5	2.0	0.0	0.0	11.8	0.0
Torcello	N	2	u2	34	23.5	38.2	35.4	0.0	0.0	0.0	2.9	0.0
Volano	N	3	sp	15	60.0	13.3	6.7	13.3	6.7	0.0	0.0	0.0
Altino	N	3	u1	43	18.6	32.6	37.2	9.3	2.3	0.0	0.0	0.0
Villa Clelia	N	3	u2	4	50.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement) ; sp = special
na = data not available

TABLE 18

Mean NISP frequency of mammalian taxa according to site type. Data derive from Table 16.

Site type (sample size)	% cattle	% sheep/ goat	% pig	% equid	% dog	% cat	% wild	% rodent
Rural (n=25)	11.9	29.7	44.7	2.2	4.6	0.2	4.5	2.1
Urban 1 (n=27)	16.2	31.2	46.8	1.4	2.8	0.4	1.0	0.1
Urban 2 (n=12)	29.4	40.1	20.8	3.1	2.2	0.0	4.3	0.1
Special (n=11)	21.2	20.7	32.1	3.6	21.0	0.0	0.7	0.7

TABLE 19

Mean MNI frequency of mammalian taxa according to site type. Data derive from Table 17.

Site type (sample size)	% cattle	% sheep/ goat	% pig	% equid	% dog	% cat	% wild	% rodent
Rural (n=21)	10.3	25.3	34.8	5.4	5.5	0.7	13.1	4.8
Urban 1 (n=18)	15.8	30.9	36.7	4.3	6.6	1.9	3.7	0.7
Urban 2 (n=7)	23.0	32.3	26.1	5.2	2.9	0.0	10.1	0.4
Special (n=11)	15.5	26.5	33.8	5.5	8.4	1.9	3.6	4.7

TABLE 20

Cattle: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type. Data derive from Tables 16 and 17.

Quantifier	Site type	Range	Variance	Standard deviation	Sample size
NISP	rural	0.0-28.0	58.2	7.6	24
	urban 1	0.8-42.3	139.0	11.8	28
	urban2	13.8-56.9	144.8	12.0	12
	special	0.0-92.7	1225.5	35.0	10
MNI	rural	0.0-21.5	25.8	5.1	20
	urban1	7.4-35.3	70.4	8.4	16
	urban2	15.8-30.0	26.8	5.2	7
	special	0.0-60.0	395.7	19.9	10

TABLE 21

Cattle: Fusion data.

Figures in bold indicate the mean frequency of cattle younger than the specific age bracket. Sample sizes are given in parentheses, with ranges indicated below them. Data derive from Appendix 3.

Site type	**Fusion age category***			
	7-10 months	**12-18 months**	**24-36 months**	**42+ months**
rural	**4.2 (n=6)**	**3.4 (n=9)**	**25.0 (n=9)**	**24.0 (n=8)**
	0.0-25.0	0.0-9.5	0.0-66.7	0.0-66.7
urban 1	**22.5 (n=2)**	**6.3 (n=5)**	**29.8 (n=6)**	**34.9 (n=6)**
	20.0-25.0	0.0-16.7	0.0-100.0	0.0-100.0
special	**0.0 (n=1)**	**0.0 (n=1)**	**0.0 (n=1)**	**33.3 (n=1)**

* The specific skeletal elements which comprise each fusion age category are listed in Appendix 19.

TABLE 22

Cattle: Dental data.

Figures in bold indicate the mean frequency of cattle in the specific dental age category. Ranges are given below indiviudal mean values. Data derive from Appendix 4.

Site type	Dental age category (approximate ages)							
	0-6 months	6-12 months	15-18 months	18-24 months	24-36 months	36+ months	48+ months	60+ months
rural (n=2)	**4.2**	**2.6**	**6.4**	**0.0**	**6.4**	**19.9**	**32.7**	**27.9**
	0.0-8.3	0.0-5.1	0.0-12.8	0.0	0.0-12.8	16.7-23.1	15.4-50.0	25.0-30.8
urban2 (n=2)	**4.7**	**4.7**	**3.4**	**0.0**	**15.4**	**17.5**	**23.5**	**28.2**
	2.7-6.7	2.7-6.7	0.0-6.7	0.0	10.8-20.0	13.3-21.6	20.0-27.0	26.7-29.7
special (n=2)	**0.0**	**7.7**	**0.0**	**0.0**	**9.1**	**29.1**	**22.1**	**32.2**
	0.0	0.0-15.4	0.0	0.0	0.0-18.2	27.3-30.8	7.7-36.4	18.2-46.2

TABLE 23

NISP frequency of cattle according to sex (part 1).

Site	R	P	T	sample size	Sex category				
					male	male/ox	ox	ox/ female	female
San Giovanni	S	2	r	2			100.0		
San Giovanni	S	3	r	7			14.3		85.7
Pompeii, Ganimede	C	1	u1	4	25.0		50.0		25.0
Altino	N	3	u1	22		9.1	50.0	9.1	31.8
Pozzuolo del Friuli	N	1	u2	5			20.0		80.0
Colognola	N	1	u2	115	0.9	37.4	5.2	2.6	53.9
Torcello	N	2	u2	2	100.0				
Innichen	N	2	u2	4		25			75.0
Stufels - Hotel	N	2	u2	4			75.0		25.0
Stufels - Senoner	N	2	u2	10	20.0		30.0		50.0
Invillino-Ibligo: pelvis	N	2,3	u2	43		20.1			79.9
Invillino-Ibligo: other bones	N	2,3	u2	55		41.8	5.4		52.8
Villa Clelia	N	3	u2	2					100.0
Aquileia	N	2	sp	398	9.0		83.9		7.0
Volano	N	3	sp	4		75.0			25.0

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

TABLE 24

NISP frequency of cattle according to sex (part 2).

These additional counts were made on the basis of metapodial measurements.

Site	**R**	**P**	**T**	**sample size**	**Sex category**				
					male	**male/ox**	**ox**	**ox/ female**	**female**
Populonia	C	1	u1	1			100.0		
Via Gabina, site 10	C	3	r	3			66.7		33.3
Carminiello	C	3	u1	5			40.0		60.0
Monte Barro	N	3	r	1					100.0

R = geographic region: C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)

TABLE 25

Cattle: Age and sex correlation.

Relative frequency displayed as series of "•," with no "•" (i.e., blank space in column) indicating absence and "••••" indicating abundance.

Site	R	P	T	sample size-sex	sample size age (teeth)	young males	older males	young females	older females
San Giovanni	S	2	r	2	fusion	•	••••		
San Giovanni	S	3	r	7	39	•	•	•	••••
Pompeii, Ganimede	C	1	u1	4	3		••••		••
Populonia	C	1	u1	1	8		••••		
Via Gabina, site10	C	3	r	3	12		•••		••
Carminiello	C	3	u1	5	fusion		••		•••
Pozzuolo del Friuli	N	1	u2	5	6	•	•	•	••••
Colognola	N	1	u2	115	15	•	•••	•	•••
Torcello	N	2	u2	2	fusion		••••		
Innichen	N	2	u2	4	5	•	•	•	••••
Stufels - Hotel	N	2	u2	4	8	•	•••	•	•
Stufels - Senoner	N	2	u2	10	9	•	•••	•	•••
Aquileia	N	2	sp	398	horns	•	••••		•
Monte Barro	N	3	r	1	2			•••	
Altino	N	3	u1	22	6	•	•••		••
Volano	N	3	sp	4	13	•	••••		••

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

TABLE 26

Cattle: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups.

R	P	Range (cm)	Mean (cm)	Var.	std. dev.	Sample size	Sample composition
S	1	na	na	na	na	na	na
S	2	137.1-146.1	141.6	40.3	6.3	2*	2 mc
S	3	112.4-139.3	125.8	58.5	7.6	10*	1 hum, 1 rad, 1 tib, 2 mc, 5 mt
C	1	109.5-134.9	124.4	123.6	11.1	4	2 mc, 2 mt
C	2	na	na	na	na	na	na
C	3	105.2-140.8	129.1	110.2	10.5	11	1 hum, 1 rad, 1 tib, 6 mc, 2 mt
N	1	100.8-128.1	114.8	110.6	10.5	7	1 hum, 1 rad, 4 mc, 1 mt
N	2	101.0-150.1	119.8	145.2	12.0	12	1 rad, 4 mc, 7 mt
N	2,3	105.1-131.5	121.8	59.5	7.7	30	1 rad, 1 tib, 13 mc, 15 mt
ALL	ALL	100.8-150.1	123.1	104.6	10.2	76	3 hum, 5 rad, 3 tib, 33 mc, 32 mt

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
hum = humerus; mc = metacarpal; mt = metatarsal; rad = radius, tib = tibia
na = data not available
* indicates data are from a single site, in this case the site of San Giovanni

TABLE 27

Cattle: Incidence of non-dental abnormalities from Roman period sites in Italy.

Site	R	P	T	infection/ osteitis	trauma/ fracture	neoplasia	osteoarthritis - extosis/eburnation			other
							MP	phal	other	
San Giovanni	S	3	r				1	1		
Carminiello	C	3	u1					3	1	1
Naples, Girolamini	C	3	u1					1		
Rome, Meta Sudans	C	3	u1		1 (rib)					
Modena	N	2	u1	1 (tib)		1 (tib)				
Monte Barro	N	3	r			1				

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)
MP = metapodial; phal = phalanx; tib = tibia

TABLE 28

Cattle: Incidence of dental abnormalities from Roman period sites in Italy.

Site	R	P	T	calculus	caries	crowding / twisting	abnormal wear	tooth loss	periodontal disease	infection/ abcess	other
Settefinestre	C	1-3	r							1	1
Carminiello	C	3	u1						3		

R = geographic region: C = central Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)

TABLE 29

Sheep/goat: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type. Data derive from Tables 16 and 17.

Quantifier	Site type	Range	Variance	Standard deviation	Sample size
NISP	rural	11.5-67.4	214.8	14.7	24
	urban 1	1.9-62.2	174.2	13.2	28
	urban2	12.3-72.6	297.9	17.3	12
	special	0.0-46.2	339.1	18.4	10
MNI	rural	15.7-52.6	85.8	9.3	20
	urban1	16.7-46.7	92.9	9.6	16
	urban2	22.0-42.6	51.4	7.2	7
	special	10.0-62.1	227.7	15.1	10

TABLE 30

NISP frequency of sheep (s) and goat (g) bones from Roman period sites in Italy.

SITE	R	P	T	NISP	# s	# g	% s	% g	Notes
Gravina (2nd BC-1st AD)	S	1	r	88	76	12	86.4	13.6	
Gravina, pit	S	1	r	49	42	7	85.7	14.3	
Gravina (7th-2nd BC)	S	1	r	18	16	2	88.9	11.1	
Vaste (Republican)	S	1	r/sp	4	3	1	75.0	25.0	
Vaste (Hellenistic)	S	1	r/sp	1	1	0	100.0	0.0	
Kaulonia	S	1	u1	27	23	4	85.2	14.8	sheep estimate
Roccagloriosa	S	1	u2	60	55	5	91.7	8.3	
Cozzo Presepe	S	1	u2	47	42	5	89.4	10.6	
Locri	S	1	sp	67	11	56	16.4	83.6	
Gravetta	S	1	sp	5	2	3	40.0	60.0	
Capaccio	S	1	sp	4	0	4	0.0	100.0	
Roccagloriosa, votive	S	1	sp	3	3		100.0	0.0	
San Giovanni	S	2	r	1	1	0	100.0	0.0	
San Giovanni	S	3	r	242	211	31	87.2	12.8	
Otranto	S	3	u1	47	31	16	66.0	34.0	all levels combined
Settefinestre	C	1	r	na	na	na	92.3	7.7	
Pompeii, Ganimede	C	1	u1	56	45	11	80.4	19.6	
Pompeii, gardens	C	1	u1	10	9	1	90.0	10.0	
Populonia	C	1	u1	222	180	42	81.1	18.9	
San Omobono	C	1	u1/sp	na	na	na	60.0	40.0	approximate values
Matrice	C	2	r	8	8	0	100.0	0.0	
San Potito	C	2	r	6	2	4	33.3	66.7	
Lugnano, villa	C	2	r	4	3	1	75.0	25.0	
Le Colonne	C	2	r	1	0	1	0.0	100.0	
Settefinestre	C	2	r	na	na	na	88.2	11.8	
Carminiello	C	2	u1	9	7	2	77.8	22.2	
Forum Transitorium	C	2	u1	2	2	0	100.0	0.0	
Via Gabina, site 10	C	3	r	45	40	5	88.9	11.1	
San Giacomo	C	3	r	16	13	3	81.3	18.8	
Matrice	C	3	r	11	8	3	72.7	27.3	
Lugnano, villa	C	3	r	1	na	1	0.0	100.0	
Settefinestre	C	3	r	na	na	na	88.9	11.1	
Monte Gelato	C	3	r	na	na	na	90.9	9.1	
Lugnano, cemetery	C	3	sp	18	10	8	55.6	44.4	
Carminiello	C	3	u1	311	185	126	59.5	40.5	
Naples, Girolamini	C	3	u1	10	8	2	80.0	20.0	
Naples, S. Patrizia	C	3	u1	4	4	0	100.0	0.0	
Rome, Meta Sudans	C	3	u1	69	53	16	76.8	23.2	
Spina	N	1	u1	na	na	na	80.0	20.0	approximate values
Colognola	N	1	u2	87	69	18	79.3	20.7	
Pozzuolo del Friuli	N	1	u2	3	3	0	100.0	0.0	
Montereale	N	1	sp	na	na	na	100.0	0.0	
Modena	N	2	u1	87	83	4	95.4	4.6	
Stufels - Senoner	N	2	u2	151	84	67	55.6	44.4	
Innichen	N	2	u2	104	95	9	91.3	8.7	
Stufels - Hotel	N	2	u2	104	70	34	67.3	32.7	
Torcello	N	2	u2	2	1	1	50.0	50.0	
Palazzo Dugentesco	N	2	u2	na	na	na	na	na	mostly sheep
Invillino	N	2,3	u2	50	40	10	80.0	20.0	
Lomello	C	3	r	na	na	na	na	na	mostly sheep
Monte Barro	N	3	r	31	31	0	100.0	0.0	

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

TABLE 31

Range and mean frequency of sheep and goats according to site type. Data derive from Table 30.

Rural (n=11)	*range*	*mean*
sheep	72.7-100.0	**87.2**
goat	0.0-27.3	**12.8**
Urban1 (n=10)	*range*	*mean*
sheep	59.5-95.4	**79.4**
goat	4.6-40.5	**20.6**
Urban2 (n=7)	*range*	*mean*
sheep	55.6-91.7	**79.2**
goat	8.3-44.4	**20.8**

TABLE 32

Range and mean frequency of sheep and goats according to geographic area. Data derive from Table 30.

South (n=8)	*range*	*mean*
sheep	66.0-91.7	**85.1**
goat	8.3-34.0	**14.9**
Central (n=12)	*range*	*mean*
sheep	59.5-90.0	**79.0**
goat	10.0-40.5	**21.0**
North (n=9)	*range*	*mean*
sheep	55.6-100.0	**82.2**
goat	0.0-44.4	**17.8**

TABLE 33

Range and mean frequency of sheep and goats according to temporal period. Data derive from Table 30.

Period 1 (n=11)	*range*	*mean*
sheep	79.3-91.7	**85.8**
goat	8.3-20.7	**14.2**
Period 2 (n=5)	*range*	*mean*
sheep	55.6-95.4	**79.6**
goat	4.6-44.4	**20.4**
Period 3 (n=12)	*range*	*mean*
sheep	59.5-100.0	**81.0**
goat	0.0-40.5	**19.0**

TABLE 34

Sheep/goat: Fusion data.

Figures in bold indicate the mean frequency of sheep/goat younger than the specific age bracket. Sample sizes are given in parentheses, with ranges indicated below them. Data derive from Appendix 6.

Site type	**Fusion age category***			
	12 months	**14-36 months**	**47-48 months**	**48-60 months**
rural	**30.7 (n=12)**	**32.2 (n=12)**	**59.2 (n=10)**	**60.7 (n=11)**
	10.0-100.0	10.4-80.0	24.4-100.0	26.7-100.0
urban 1	**23.8 (n=10)**	**27.7 (n=10)**	**48.0 (n=10)**	**62.4 (n=10)**
	0.0-100.0	9.1-66.7	25.3-70.6	33.3-100.0
urban 2	**2.9 (n=1)**	**45.7 (n=1)**	**25.0 (n=1)**	**78.3 (n=1)**
special	**2.7 (n=1)**	**15.0 (n=1)**	**35.1 (n=1)**	**25.0 (n=1)**

* the specific skeletal elements which comprise each fusion age category are listed in Appendix 19.

TABLE 35

Sheep/goat: Dental data.

Figures in bold indicate the mean frequency of sheep/goat in the specific age category. Ranges given below indiviudal mean values. Data derive from Appendix 7.

Site Type	Dental age category (approximate age)							
	0-2 months	3-6 months	7-12 months	12-24 months	24-36 months	36-48 months	48+ months	72+ months
rural (n=10)	**3.4**	**16.2**	**11.7**	**30.7**	**10.9**	**12.0**	**11.0**	**4.1**
	0.0-33.3	0.0-41.7	0.0-30.8	0.0-58.8	0.0-25.1	0.0-25.0	0.0-41.2	0.0-17.6
urban1 (n=7)	**0.0**	**2.7**	**16.7**	**12.6**	**19.2**	**27.9**	**18.2**	**2.7**
		0.0-7.1	0.0-36.8	0.0-31.0	3.7-50.0	10.0-56.3	0.0-40.0	0.0-13.3
urban2 (n=6)	**0.0**	**12.9**	**17.8**	**19.1**	**30.4**	**13.0**	**6.8**	**0.0**
		3.2-27.3	0.0-26.9	7.7-25.1	21.1-40.0	9.1-15.8	0.0-15.4	
special (n=2)	**0.0**	**7.7**	**5.3**	**14.4**	**18.4**	**9.1**	**42.7**	**2.7**
		0.0-15.4	0.0-10.5	7.7-21.1	15.4-21.1	7.7-10.5	31.6-53.8	0.0-5.3

TABLE 36

NISP frequency of sheep/goats according to sex.

Site	R	P	T	sample size	% males	% castrates	% females
Gravina (7th-2nd BC)	S	1	r	3	33.3		66.7
Gravina (2nd BC-1st AD)	S	1	r	5			100.0
Gravina, pit	S	1	r	11	9.1		90.9
Cozzo Presepe	S	1	u2	3			100.0
San Giovanni	S	3	r	11	45.4		54.6
Otranto	S	3	u1	19	36.8		63.2
Pompeii, Ganimede	C	1	u1	7	57.1		42.9
Matrice	C	2	r	1	100.0		
Matrice	C	3	r	2	50.0		50.0
San Giacomo	C	3	r	1			100.0
Colognola	N	1	u2	9	11.1	22.2	66.7
Pozzuolo del Friuli	N	1	u2	1			100.0
Montereale	N	1	sp	6	50.0		50.0
Innichen	N	2	u2	11	9.1	36.4	54.5
Stufels - Hotel	N	2	u2	16	25.0	6.3	68.8
Stufels - Senoner	N	2	u2	26	57.7		42.3
Invillino	N	2,3	u2	31	41.9		58.1
Monte Barro	N	3	r	1			100.0

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

TABLE 37

Sheep/goat: Age and sex correlation.

Relative frequency displayed as series of "•," with no "•" (i.e., blank space in column) indicating absence and "••••" indicating abundance.

Site	R	P	T	sample size sex	sample size age (teeth)	young males	older males	young females	older females
Gravina (7th-2nd BC)	S	1	r	3	17		•		•••
Gravina (2nd BC-1st AD)	S	1	r	5	17				••••
Gravina, pit	S	1	r	11	12	••		••	•
Cozzo Presepe	S	1	u2	3	19	•		•	•••
San Giovanni	S	3	r	11	518	•	•	•	•
Otranto	S	3	u1	19	fusion		••		•••
Matrice	C	2	r	1	35		•		
Matrice	C	3	r	2	53	•	•	•	•
San Giacomo	C	3	r	1	fusion				•
Pompeii, Ganimede	C	1	u1	7	19	••	•	•	•
Colognola	N	1	u2	9	31	•	•	•	••
Pozzuolo del Friuli	N	1	u2	1	fusion				•••
Montereale	N	1	sp	6	13	•	••	•	••
Innichen	N	2	u2	11	11	•	•	•	••
Stufels - Hotel	N	2	u2	16	16	•	•	•	••
Stufels - Senoner	N	2	u2	26	15	•	••	•	•
Invillino	N	2,3	u2	31	175	•	•	•	•
Monte Barro	N	3	r	1	23				•

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

TABLE 38

Sheep/goat: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups.

R	P	Range (cm)	Mean (cm)	Mean (w/o astrag)	Var.	std. dev.	Sample size	Sample composition
S	1	56.0-76.2	66.4	63.4	20.9	4.6	63	1 hum, 1 rad, 7 mc, 3 mt, 42 astrag, 9 cal
S	2	61.5-73.3	66.8	na	35.6	6.0	3*	3 astrag
S	3	60.2-74.2	67.0	66.7	18.6	4.3	17*	1 rad, 1 mt, 6 astrag, 9 cal
C	1	53.6-75.8	65.8	66.4	23.2	4.8	38	1 rad, 5 mc, 4 mt, 10 astrag, 18 cal
C	2	65.3-74.1	69.8	71.8	13.0	3.6	4	2 astrag, 2 cal
C	3	59.2-79.4	69.1	68.7	23.0	4.8	60	3 rad, 1 fem, 6 mc, 5 mt, 28 astrag, 17 cal
N	1	58.4-77.1	65.1	63.9	23.3	4.8	43	1 hum, 6 mc, 1 tib, 3 mt, 25 astrag, 7 cal
N	2	58.7-77.1	68.3	66.7	29.1	5.4	53	1 rad, 3 mc, 6 mt, 35 astrag, 8 cal
N	2/3	57.6-88.9	64.8	64.7	37.3	6.1	29	1 rad, 2 mt, 22 astrag, 4 cal
ALL	**ALL**	**53.6-88.9**	**66.9**	**66.1**	**26.5**	**5.2**	**310**	**2 hum, 8 rad, 1 fem, 1 tib, 27 mc, 24 mt, 173 astrag, 74 cal**

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
astrag = astragalus; cal = calcaneus; hum = humerus; fem = femur; mc = metacarpal; mt = metatarsal; rad = radius, tib = tibia
* indicates data are from a single site
na = data not available

2

TABLE 39

Sheep/goat: Incidence of non-dental abnormalities from Roman period sites in Italy.

Site	**R**	**P**	**T**	infection/ osteitis	trauma/ fracture	neoplasia	osteoarthritis - extosis/eburnation			other
							MP	phal	other	
Populonia	C	1	u1					1		
Settefinestre	C	1-3	r	1 (phal)	2 (tib, fem)			1	1 (rad)	1
Carminiello	C	1,2	u1						1	1
Carminiello	C	3	u1					1		
Naples, S. Patrizia	C	3	u1					1		
Monte Barro	N	3	r					1		

R = geographic region: C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)
fem = femur; MP = metapodial; phal = phalanx; rad = radius; tib = tibia

TABLE 40

Sheep/goat: Incidence of dental abnormalities from Roman period sites in Italy.

Site	R	P	T	calculus	crowding / twisting	abnormal wear	tooth loss	periodontal disease	infection/ abcess	other
Gravina	S	1	r	some						
San Giovanni	S	3	r	some		1				
Settefinestre	C	1-3	r	1	1	2	1	5	1	1
Carminiello	C	1,2	u1					1		
San Costanzo	C	2	r					1		
Monte Gelato	C	2,3	r						1	
San Giacomo	C	3	r	common					1	
Matrice	C	3	r	2						
Carminiello	C	3	u1		2		2	5		1
Naples, Girolamini	C	3	u1	common		2				2
Naples, S. Patrizia	C	3	u1	common					1	
Lomello	N	3	r			1				

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)

TABLE 41

Pig: Range, variance, standard deviation, and sample size of NISP and MNI frequencies by site type. Data derive from Tables 16 and 17.

Quantifier	Site type	Range	Variance	Standard deviation	Sample size
NISP	rural	14.5-72.6	262.2	16.2	24
	urban1	13.1-84.1	325.2	18.0	28
	urban2	8.3-32.0	87.2	9.3	12
	special	0.0-97.2	1099.2	33.2	10
MNI	rural	17.6-51.5	87.4	9.3	20
	urban1	17.6-70.0	180.1	13.4	16
	urban2	12.2-35.4	54.6	7.4	7
	special	0.0-76.9	779.7	27.9	10

TABLE 42

Pig: Fusion data.

Figures in bold indicate the mean frequency of pig younger than the specific age bracket. Sample sizes given in parentheses, with ranges indicated below. Data derive from Appendix 9.

Site type	**Fusion age category***		
	11 months	**19-23 months**	**31-35+ months**
rural	**47.2 (n=15)**	**62.5 (n=15)**	**85.5 (n=14)**
	0.0-85.1	20.0-100.0	16.7-100.0
urban1	**25.6 (n=12)**	**73.7 (n=12)**	**85.9 (n=11)**
	0.0-74.4	34.1-100.0	50.0-100.0
urban2	**50.0 (n=1)**	**38.5 (n=1)**	**100.0 (n=1)**
special	**65.6 (n=3)**	**68.0 (n=3)**	**90.1 (n=3)**
	61.8-68.2	54.5-84.4	80.0-95.8

* the specific skeletal elements which comprise each fusion age category are listed in Appendix 19.

TABLE 43

Pig: Dental data.

Figures in bold indicate the mean frequency of pig in than the specific dental age category. Ranges given below indiviudal mean values. Data derive from Appendix 10.

Site type	Dental age category (approximate age)							
	fetal/ newborn	1-3 months	3-6 months	6-12 months	12-18 months	18-24 months	24+ months	30+ months
rural (n=7)	**2.3**	**1.3**	**8.8**	**19.3**	**25.9**	**23.3**	**9.9**	**9.1**
	0.0-9.6	0.0-6.7	0.0-27.6	6.6-50.0	0.0-50.0	0.0-30.0	2.9-50.0	0.0-28.9
urban1 (n=7)	**0.0**	**0.0**	**17.1**	**13.6**	**16.2**	**13.0**	**23.0**	**17.2**
			0.0-44.7	0.0-42.9	0.0-28.9	0.0-36.4	0.0-42.9	0.0-44.6
urban2 (n=4)	**0.0**	**0.0**	**19.6**	**16.9**	**16.4**	**18.5**	**19.3**	**9.3**
			13.9-31.3	0.0-38.9	6.3-22.6	13.1-22.2	5.6-31.3	0.0-14.6
special (n=2)	**1.7**	**1.1**	**9.9**	**20.8**	**18.1**	**26.7**	**7.2**	**14.8**
	0.0-3.3	0.0-2.2	5.4-14.3	13.0-28.6	3.6-32.6	25.0-28.3	0.0-14.3	14.3-15.2

TABLE 44

NISP frequency of pigs according to sex.

Site	R	P	T	sample size	% males	% females
Gravina (2nd BC-1st AD)	S	1	r	12	58.3	41.7
Vaste	S	1	r/sp	3	33.3	66.7
Locri	S	1	sp	3	33.3	66.7
Cozzo Presepe	S	1	u2	2	50.0	50.0
Roccagloriosa	S	1	u2	17	76.5	23.5
San Giovanni	S	2	r	7	28.6	71.4
San Giovanni	S	3	r	883	55.4	44.6
Otranto	S	3	u1	4	75.0	25.0
Settefinestre	C	1	r	7	28.6	71.4
Matrice	C	1	r	27	59.3	40.7
Via Gabina, site 11	C	1,2	r	13	69.2	30.8
Populonia	C	1	u1	48	70.8	29.2
San Omobono	C	1	u1/sp	6	83.3	16.7
Pompeii, Ganimede	C	1	u1	5	80.0	20.0
Carminiello	C	1,2	u1	9	55.6	44.4
Lugnano, villa	C	2	r	3	33.3	66.7
Settefinestre	C	2	r	82	41.5	58.5
San Giacomo	C	3	r	8	100.0	0.0
Settefinestre	C	3	r	24	45.8	54.2
Matrice	C	3	r	23	87.0	13.0
Via Gabina, site 10	C	3	r	66	65.2	34.8
Lugnano, cemetery	C	3	sp	29	62.1	37.9
Naples, S. Patrizia	C	3	u1	17	35.3	64.7
Naples, Girolamini	C	3	u1	22	72.7	27.3
Carminiello	C	3	u1	37	83.8	16.2
Rome, Meta Sudans	C	3	u1	na	70.0	30.0
Spina	N	1	u1	na		primarily females
Pozzuolo del Friuli	N	1	u2	7	71.4	28.6
Colognola	N	1	u2	49	51.0	49.0
Montereale	N	1	sp	10	80.0	20.0
Modena	N	2	u1	9	33.3	66.7
Torcello	N	2	u2	2	50.0	50.0
Stufels - Hotel	N	2	u2	8	50.0	50.0
Stufels - Senoner	N	2	u2	6	83.3	16.7
Invillino	N	2,3	u2	384	77.9	22.1
Monte Barro	N	3	r	12	75.0	25.0
Altino	N	3	u1	27	51.9	48.1

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

TABLE 45

Pig: Age and sex correlation.

Relative frequency displayed as series of "•," with no "•" (i.e., blank space in column) indicating absence and "••••" indicating abundance.

Site	R	P	T	sample size-sex	sample size age (teeth)	young males	older males	young females	older females
Gravina (2nd BC -1st AD)	S	1	r	12	30	••	•	•	•
Vaste	S	1	r/sp	3	6	••			•••
Locri	S	1	sp	3	8	•		•	•••
Cozzo Presepe	S	1	u2	2	18	•	•	•	•
Roccagloriosa	S	1	u2	17	category	•••	••	•	•
San Giovanni	S	2	r	7	17	••	•	••	•••
San Giovanni	S	3	r	883	2253	•••	•	•	••
Otranto	S	3	u1	4	14	••	•		•
Settefinestre	C	1	r	7	38 (P1,2,3)	••	•	•	•••
Via Gabina, site 11	C	1,2	r	13	5	•	••		••
San Omobono	C	1	u1/sp	6	category	••••	•	••	•
Populonia	C	1	u1	48	38	••	•	•	••
Pompeii, Ganimede	C	1	u1	5	1		••		•
Carminiello	C	1,2	u1	9	fusion	•	••		••
Matrice	C	2	r	27	16	•	•	•	•
Lugnano, villa	C	2	r	3	fusion		•		••
Settefinestre	C	2	r	82	38 (P1,2,3)	••	•	•	•••
San Giacomo	C	3	r	8	1	•			
Settefinestre	C	3	r	24	38 (P1,2,3)	••	•	•	•••
Matrice	C	3	r	23	4	••	••		•
Via Gabina, site 10	C	3	r	66	52	•••	•		•••
Lugnano, cemetery	C	3	sp	29	92	••	•		••
Naples, S. Patrizia	C	3	u1	17	fusion	••	•	•	•••
Naples, Girolamini	C	3	u1	22	fusion	•••		•	•
Carminiello	C	3	u1	37	68	••	•		•
Rome, Meta Sudans	C	3	u1	na	35	•••	•	••	••
Pozzuolo	N	1	u2	7	5	••	••		••
Colognola	N	1	u2	49	30	••	•		•••
Modena	N	2	u1	9	18	••	•		••••
Stufels - Hotel	N	2	u2	8	16	••	•		•••
Stufels - Senoner	N	2	u2	6	9	•••	••		••
Invillino	N	2,3	u2	384	137	•	••		••
Monte Barro	N	3	r	12	9	•••	•		•
Altino	N	3	u2	27	16	•	••		•••

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

TABLE 46

Pig: Range, mean, variance (var.), standard deviation (std. dev.), and sample composition for withers heights from region and temporal period groups.

R •	P	Range (cm)	Mean (cm)	Var.	std. dev.	Sample size	Sample composition
S	1	59.1-75.2	69.4	24.7	5.0	7	5 astrag, 2 cal
S	3	62.1-71.6	68.3	18.9	4.4	4*	4 astrag
C	1	59.1-74.7	65.7	22.4	4.7	16*	11 astrag, 5cal
C	2	57.9-85.5	72.4	86.4	9.3	13	11 astrag, 2 cal
C	3	57.3-84.1	70.1	38.7	6.2	27	27 astrag
N	1	64.4-80.9	70.3	19.5	4.4	12	11 astrag, 1 cal
N	2	65.3-73.4	68.7	7.8	2.8	9	9 astrag
N	2/3	59.8-78.8	70.4	24.7	5.0	28	1 fem, 18 astrag, 9 cal
ALL	**ALL**	**57.3-85.5**	**69.6**	**34.1**	**5.8**	**116**	**1 fem, 96 astrag, 19 cal**

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
fem = femur; astrag = astragalus; cal = calcaneus
* indicates data are from a single site

TABLE 47

Pig: Incidence of non-dental abnormalities from Roman period sites in Italy.

Site	R	P	T	abnormal development	infection/ osteitis	trauma/ fracture	osteoarthritis - extosis/eburnation			other
							MP	phal	other	
San Giovanni	S	3	r			1 (MT2)				
Populonia	C	1	u1	1 (no PM2)						
Settefinestre	C	1-3	r		1 (MP3)				1 (astrag)	
Carminiello	C	3	u1			1				1
Naples, Girolamini	C	3	u1	1 (no PM1)						
Rome, Meta Sudans	C	3	u1							1 (fusion of carpals)
Modena	N	2	u1			2 (MT4, MP)				
Monte Barro	N	3	r	1 (unfused parietal)	1 (MP)					

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city)
astrag = astragalus; MP = metapodial; MT = metatarsal; PM = premolar

TABLE 48

Pig: Incidence of dental abnormalities from Roman period sites in Italy.

Site	**R**	**P**	**T**	calculus	caries	crowding / twisting	abnormal wear	tooth loss	periodontal disease	infection/ abcess	other
Roccagloriosa	S	1	u2			2					
San Giovanni	S	2,3	r			2					1
Carminiello	C	1,2	u1	3					1	1	
Settefinestre	C	1-3	r						3		1
Monte Gelato	C	2,3	r		1						
San Giacomo	C	3	r					2			
Carminiello	C	3	u1	18			3		6	9	3
Naples, Girolamini	C	3	u1			1					
Naples, S. Patrizia	C	3	u1				1		1		
Rome, Meta Sudans	C	3	u1								1 (resorption PM1)
Modena	N	2	u1			1					
Monte Barro	N	3	r				1		1		

R = geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
PM = premolar

TABLE 49

Cattle: Butchery data.

Site	R	P	T	Skeletal element												
				head	neck	scap	hum	vert	ribs	pelv	fem	rad/ ulna	tib	MP	carp/ tars	phal
Gravina	S	1	r	proportion cut; in many cases partly or wholly chopped through; no difference in proportion of knife and chop-marks												
Locri	S	1	sp		m	d-m		m, bis	m	b-m		p-m	p-m d-m	p-m d-m	m	m
Cozzo Presepe	S	1	u2					bis								
Roccagloriosa	S	1	u2						c			c				
San Giovanni	S	3	r		c	d-c,k	p-c b-c d- c,k,s	c,k, bis	c,k	c	p-c,s b-c d-c	p-c,k b-k; d-c,s	p-c,s; b-c,k; d-c	p-c,s; b-c; d-c	c,k	p-c,k; b-c,k; d-c,k
Settefinestre	C	1-3	r	m	m.	d-c	p-c; b-c; d-c	m, bis?	m	c	p-c; d-c	p-c; d-c	p-c; d-c	p-c; b-c; d-c		
Pompeii 94	C	1	u1	little evidence												
San Omobono	C	1	u1						m							
Populonia	C	1	u1		m	d-m	p-m; d-m	m, bis?			p-m; d-m	p-m; d-m		d-m	m	p-m
Le Colonne	C	2	r	cattle bones broken for marrow												
Pompeii, gardens	C	2	u1	s		m		m	m		d-m		d-c	m	m	
Saepinum	C	2	u1	similar to Matrice												
Pistoia	C	2	u1								d-c					
Cosa lagoon	C	2	u1				m									
San Giacomo	C	3	r								p-s; b-c	p-c, b-c	b-c			
Via Gabina, site 10	C	3	r			m	d-m		m	b-m				p-m; b-m; d-m		p-m
Matrice	C	2,3	r			d-m	b-m; d-m				d-m	p-m		d-m	p-m	b-m
Campochiaro	C	3	sp	similar to Matrice												
Lugnano, cemetery	C	3	sp	c		d-c	d-c	c, bis	c,k	b-c			p-c; d-c	p-c		
Carminiello	C	3	u1			m	m	m, bis		m	p-m; d-m	m	m	m	m	m
Colognola	N	1	u2	m				m, bis				p-m		b-m	m	m
Pozzuolo del Friuli	N	1	u2	ends of long bones preserved intact - bones split in centre?												
Innichen	N	2	u2	bones fragmented from butchery?												
Palazzo Dugentesco	N	2	u2	m		m		bis	m							
Stufels - combined	N	2	u2			m	m	m		m	m	m	m	m		
Torcello	N	2	u2					m							m	
Volano	N	2,3	sp	some bones butchered - no details												
Invillino	N	2,3	u2	butchery noted but no details												
Monte Barro	N	3	r	m	m		d-m	m, bis	m	b-m	d-m	p-m; d-m		b-m; d-m		p-m
Altino	N	3	u1		c	d-c				m						
Villa Clelia	N	3	u2	c				m	m	b-c						

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

skeletal elements:
neck = atlas/axis; scap = scapula; hum = humerus; vert = vertebrae; pelv = pelvis; fem = femur; rad = radius; tib = tibia;
MP = metapodial; carp/tars = carpal/tarsal; phal = phalanges

butchery marks:
p = proximal end of bone; **b** = body or medial portion of bone; **d** = distal end of bone
s = s awn; **c** = chop mark from a cleaver; **k** = knife cut; **bis** = bisected
m = butchery mark (not identified in report but likely a cleaver chop or knife cut)

TABLE 50

Sheep/goat: Butchery data.

Site	R	P	T	Skeletal element												
				head	neck	scap	hum	vert	ribs	pelv	fem	rad/ ulna	tib	MP	carp/ tars	phal
Gravina	S	1	r	proportion cut; in many cases partly or wholly chopped through; no difference in proportion of knife and chop-marks												
Gravina pit	S	1	r									p-ck d-ck		p-ck b-k d-c		
Locri	S	1	sp			b-m d-m	d-m		m	b-m		p-m	d-m	b-m; d-m	m	
Roccagloriosa, votive	S	1	sp	no signs of meat removal												
Cozzo Presepe	S	1	u2					bis								
Metaponto, kiln	S	1	u2	some butchery												
San Giovanni	S	3	r	c,k		b-c d-c	p-c b-c,k d-c	c,k, bis	c,k	c,k	p-c,k	p-c,k b-c,k d-c,k	p-c b-c; d-c	p-c b-c d-c,k	c,k	
Via Gabina 11	C	1,2	r				b-s		m							
Settefinestre	C	1-3	r		m	d-c	b-c	m; bis?	m	c	p-c	b-c	b-c	b-c		
Pompeii 94	C	1	u1	little evidence												
San Omobono	C	1	u1					m	m							
Populonia	C	1	u1	m	m	d-m	d-m	m, bis?		m	p-m; d-m	p-m; d-m	b-m; d-m	p-m; d-m	m	
Saepinum	C	2	u1	similar to Matrice												
Matrice	C	2,3	r			d-m	d-m			p-m; b-m		b-m				
Monte Gelato	C	2,3	r			m	m	c, bis				m		m		
San Giacomo	C	3	r	k		d-c	p-c d-c,s			b-c	p-c; b-c; d-c	p-c; b-k	p-c b-c; d-c	p-k b-k d-k		
Via Gabina, site 10	C	3	r			k		m	m, bis	b-m	p-m; d-m		p-m b-m d-m		m	
Campochiaro	C	3	sp	similar to Matrice												
Lugnano, cemetery	C	3	sp			d-c	d-c		c,k			p-c				
Carminiello	C	3	u1	m	m	d-m	d-m	m, bis		b-m	p-m	p-m d-m	d-m	m	m	
Naples, Girolamini	C	3	u1	m		d-c	p-c	m		b-c	p-c	m	m	m		m
Naples, S. Patrizia	C	3	u1				m				m	m	m	m		
Colognola	N	1	u2	m	m		d-m	m, bis						m	m	m
Pozzuolo del Friuli	N	1	u2					bis								
Innichen	N	2	u2					m, bis								
Palazzo Dugentesco	N	2	u2	m		m		bis	m							
Stufels - combined	N	2	u2			m	m	m, bis		m	m	m	m	m		
Torcello	N	2	u2	ends of long bones preserved intact - bones split in centre?												
Invillino	N	2,3	u2	butchery marks noted but no details												
Monte Barro`	N	3	r	m	m	b-m d-m	b-m d-m	m, bis	m	p-m b-m	p-m b-m d-m	p-m b-m	p-m d-m	p-m b-m d-m		m
Altino	N	3	u1	butchery marks rare												

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

skeletal elements:
neck = atlas/axis; scap = scapula; hum = humerus; vert = vertebrae; pelv = pelvis; fem = femur; rad = radius; tib = tibia; MP = metapodial; carp/tars = carpal/tarsal; phal = phalanges

butchery marks:
p = proximal end of bone; b = body or medial portion of bone; d = distal end of bone
s = s awn; c = chop mark from a cleaver; k = knife cut; bis = bisected
m = butchery mark (not identified in report but likely a cleaver chop or knife cut)

TABLE 51

Pig: Butchery data.

Site	R	P	T	Skeletal element												
				head	neck	scap	hum	vert	ribs	pelv	fem	rad/ ulna	tibia	MP	carp/ tars	phal
Gravina	S	1	r								b-s					
Vaste (Hellenistic)	S	1	r/sp		c,k	b-c; d-c			c		b-k; d-c		p-c; b-k		k	
Locri	S	1	sp			b-m; d-m	b-m; d-m					p-m	b-m; d-m	p-m	m	
Metaponto, kiln	S	1	u2	some butchery												
San Giovanni	S	3	r	s,c,k	c	b-c,k; d-c,k	p-c,k; b-c,k; d-c,k	c,k, bis	c,k	c,k		p-s,ck b-c,k; d-s,ck	p-c; b-c, d-c	p-s,c; d-c	s,c,k	c,k
Via Gabina, site 11	C	1,2	r						m							
Settefinestre	C	1-3	r	m	m	d-c	p-c; d-c	m; bis?	m	c	p-c		b-c	b-c		
Pompeii 94	C	1	u1	little evidence												
San Omobono	C	1	u1	some evidence; more evidence on bones of older pigs												
Populonia	C	1	u1	m	m	d-m	p-m; d-m	m, bis?		m	p-m; d-m	p-m; b-m; d-m	p-m; d-m	p-m; d-m	m,k	
Pompeii, gardens	C	2	u1	c,k		m										
Saepinum	C	2	u1	similar to Matrice												
Pistoia	C	2	u1												m	
Cosa lagoon	C	2	u1				d-m									
San Costanzo	C	2	r													m,s
Matrice	C	2,3	r	m		d-m	d-m	bis		p-m; b-m	p-m; d-m	p-m	b-m; d-m	p-m	m	
Monte Gelato	C	2,3	r			m	m	c, bis				m		m		
San Giacomo	C	3	r			d-c	p-c; d-c,s			b-c	p-c; b-c	p-c; b-c; d-c	p-c; b-c,s			
Via Gabina, site 10	C	3	r			p-m	p-m; d-m	m	m, bis	b-m		p-m; d-m	d-m	p-m; d-m		p-m
Campochiaro	C	3	sp	similar to Matrice												
Lugnano, cemetery	C	3	sp	c			d-c	c, bis	c,k				d-c	p-c; d-c	m	p-c; d-c
Carminiello	C	3	u1	m		d-m	m	m		b-m	m	m	m	m	m	m
Naples, Girolamini	C	3	u1	m		d-c	p-c			b-c	p-c	m	m	m	m	m
Naples, S. Patrizia	C	3	u1	m		m	m			m	m	m		m	m	
Colognola	N	1	u2	m,c		d-c		m, bis		b-m	d-c			m	m	m
Innichen	N	2	u2	bones fragmented from butchery?												
Palazzo Dugentesco	N	2	u2	m		m		bis	m							
Stufels - combined	N	2	u2			m	m	m, bis		m	m	m	m	m		
Torcello	N	2	u2			d-m	d-m				m		m			
Invillino	N	2,3	u2	butchery marks noted but no details												
Monte Barro	N	3	r	m	m	b-m; d-m	p-m; b-m; d-m	m, bis	m	b-m	p-m; b-m; d-m	p-m; b-m; d-m;	p-m; b-m; d-m	p-m; d-m	m	m
Altino	N	3	u1	butchery marks rare - no other details												

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

skeletal elements:
neck = atlas/axis; scap = scapula; hum = humerus; vert = vertebrae; pelv = pelvis; fem = femur; rad = radius; tib = tibia; MP = metapodial; carp/tars = carpal/tarsal; phal = phalanges

butchery marks:
p = proximal end of bone; **b** = body or medial portion of bone; **d** = distal end of bone
s = s awn; **c** = chop mark from a cleaver; **k** = knife cut; **bis** = bisected
m = butchery mark (not identified in report but likely a cleaver chop or knife cut)

TABLE 52

Mean meat weights (kg) for individual cattle, sheep/goat, and pigs from Roman Italy according to region and time period groups.

Region	Period	Taxon		
		Cattle	Sheep/goat	Pig
S	1	192.4*	28.0	47.1
S	2	196.4**	28.2	46.7*
S	3	200.2	28.4	46.0
C	1	198.2	27.2	43.4
C	2	196.4*	31.2	50.1
C	3	195.4	30.5	47.8
N	1	178.0	26.5	48.0
N	2	187.8	29.7	46.4
N	2/3	192.4	26.2	48.1
ALL	**ALL**	**189.6**	**28.3**	**47.3**

Geographic regions: S = southern Italy; C = central Italy; N = northern Italy
Temporal periods: 1 = c. Republic; 2 = c. Imperial Period ; 3 = c. Late Antiquity
* indicates estimated value since no corresponding withers height value was available
** corresponding withers height from Table 26 suggests a meat weight value of 231.6 kg, which is quite high relative to other values (and based on two measurements from animals at one site). A lower estimate of 196.4 kg is used in this case.

TABLE 53

Domestic and wild mammal mean meat weight frequencies according to geographic region, time period, and site type groups.

Values calculated on the basis of MNI figures. Individual sample sizes are given in parentheses. Data derive from Appendix 13.

Region	P	Rural		Urban 1		Urban 2		Special	
		domestic	wild	domestic	wild	domestic	wild	domestic	wild
South	1	89.2 (2)	10.8 (2)	98.9 (1)	1.1 (1)	89.4 (1)	10.6 (1)	93.6 (4)	6.5 (4)
	2	91.4 (1)	8.6 (1)	na	na	na	na	na	na
	3	97.3 (1)	2.7 (1)	96.6 (1)	3.4 (1)	na	na	na	na
Central	1	88.5 (2)	11.5 (2)	97.6 (4)	2.4 (4)	na	na	100.0 (1)	0.0 (1)
	2	88.6 (8)	11.4 (8)	100.0 (2)	0.0 (2)	na	na	100.0 (1)	0.0 (1)
	3	92.2 (6)	7.8 (6)	97.2 (7)	2.8 (7)	na	na	94.0 (1)	6.0 (1)
North	1	na	na	na	na	88.4 (2)	11.6 (2)	99.8 (1)	0.2 (1)
	2	na	na	98.9 (1)	1.1 (1)	95.0 (4)	5.0 (4)	100.0 (1)	0.0 (1)
	3	na	na	100.0 (1)	0.0 (1)	na	na	100.0 (1)	0.0 (1)
ALL	ALL	**90.3 (20)**	**9.7 (20)**	**98.1 (17)**	**1.9 (17)**	**92.3 (7)**	**7.7 (7)**	**96.4 (10)**	**3.6 (10)**

P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
na = data not available

TABLE 54

Mean meat weight frequencies for cattle, sheep/goat, and pigs at "special" sites; calculated on the basis of NISP values.. Data derive from Appendix 14.

Region	Period	Cattle	Sheep/goat	Pig
South	1	37.8 (n=2)	7.0 (n=2)	55.2 (n=2)
	2	na	na	na
	3	na	na	na
Central	1	28.4 (n=1)	40.3 (n=1)	31.3 (n=2)
	2	2.6 (n=1)	22.6 (n=1)	74.7 (n=1)
	3	45.1 (n=2)	13.0 (n=2)	41.9 (n=2)
North	1	2.3 (n=1)	31.7 (n=1)	66.0 (n=1)
	2	100.0 (n=1)	0.0 (n=1)	0.0 (n=1)
	3	99.4 (n=1)	0.2 (n=1)	0.4 (n=1)

Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
na = data not available

TABLE 55

Mean meat weight frequencies for cattle, sheep/goat, and pigs per site type; calculated on the basis of NISP values. Data derive from Appendix 14.

Taxon	Period	Rural (n=21)	Urban 1 (n=27)	Urban 2 (n=13)	Special (n=9)
Cattle	ALL	40.9	45.7	70.0	44.3
Sheep/goat	ALL	17.2	14.8	16.1	15.0
Pig	ALL	41.9	39.6	13.9	40.7

TABLE 56

Mean meat weight frequencies for cattle, sheep/goat, and pigs at "special" sites; calculated on the basis of MNI values. Data derive from Appendix 15.

Region	Period	Cattle	Sheep/goat	Pig
South	1	51.3 (n=3)	15.3 (n=3)	33.3 (n=3)
	2	na	na	na
	3	na	na	na
Central	1	26.0 (n=1)	43.1 (n=1)	30.9 (n=1)
	2	6.1 (n=1)	13.9 (n=1)	79.9 (n=1)
	3	45.6 (n=2)	11.7 (n=2)	42.7 (n=2)
North	1	9.6 (n=1)	18.1 (n=1)	72.3 (n=1)
	2	na	na	na
	3	94.5 (n=1)	2.9 (n=1)	2.6 (n=1)

Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
na = data not available

TABLE 57

Mean meat weight frequencies for cattle, sheep/goat and pigs per site type; calculated on the basis of MNI values. Data derive from Appendix 15.

Taxon	Period	Rural (n=16)	Urban 1 (n=16)	Urban 2 (n=7)	Special (n=10)
Cattle	ALL	44.1	50.6	66.0	46.7
Sheep/goat	ALL	19.2	17.5	14.7	15.3
Pig	ALL	36.7	31.9	19.3	38.0

TABLE 58

Range and mean frequency of cattle parts according to site type; calculated using NISP frequencies for those bones which comprise each category. Data derive from Appendix 16.

Site type (sample size)	**Skeletal part category**							
	Head		**Primary**		**Secondary**		**Extremity**	
	range	mean	range	mean	range	mean	range	mean
Rural (n=9)	2.2-53.6	**34.0**	14.5-29.4	**20.1**	10.8-27.9	**14.6**	11.6-65.2	**31.2**
Urban 1 (n=10)	10.2-49.7	**30.4**	13.5-36.7	**24.0**	1.8-32.7	**13.0**	13.5-64.9	**32.5**
Urban 2 (n=7)	2.4-57.9	**35.7**	8.3-40.0	**20.6**	4.3-19.5	**8.8**	17.9-69.0	**34.9**
Special (n=5)	12.3-68.9	**40.1**	12.9-24.1	**20.2**	3.7-20.2	**13.7**	4.9-46.6	**25.9**

TABLE 59

Cattle parts mean frequencies as standardized statistic for site type. Data derive from Table 58 and Appendix 16.

Site type (sample size)	**Skeletal part category**			
	Head	**Primary**	**Secondary**	**Extremity**
Rural (n=9)	3.8	5.0	4.9	5.2
Urban 1 (n=10)	3.4	6.0	3.3	5.4
Urban 2 (n=7)	4.0	5.2	2.9	5.8
Special (n=5)	4.5	5.1	4.6	4.3

TABLE 60

Cattle parts mean frequencies as standardized statistic for geographic area and site type. Data derive from Appendix 16.

Region/ site type (sample size)	Skeletal part category			
	Head	Primary	Secondary	Extremity
SOUTHERN ITALY				
rural (n=2)	1.9	3.9	4.4	9.0
urban (n=2)	3.7	3.6	2.7	6.9
special (n=1)	3.1	3.2	5.9	6.9
ALL TYPES (n=5)	**2.9**	**4.0**	**4.0**	**7.7**
CENTRAL ITALY				
rural (n=5)	3.9	5.9	5.0	4.4
urban (n=7)	2.7	6.1	5.0	6.1
special (n=2)	6.8	5.3	1.9	2.0
ALL TYPES (n=14)	**3.7**	**5.9**	**4.5**	**4.9**
NORTHERN ITALY				
rural (n=2)	5.3	4.0	5.0	3.5
urban (n=8)	4.4	5.6	3.0	4.7
special (n=2)	2.8	5.7	6.6	5.4
ALL TYPES (n=12)	**4.3**	**5.4**	**3.9**	**4.7**

TABLE 61

Cattle parts mean frequencies as standardized statistic for temporal period. Data derive from Appendix 16.

Period (sample size)	Skeletal part category			
	Head	Primary	Secondary	Extremity
Period 1 (n=7)	2.8	5.5	3.4	7.1
Period 2 (n=8)	4.1	4.1	3.8	5.9
Period 3 (n=16)	4.1	6.0	4.8	4.2

TABLE 62

Range and mean frequency of sheep/goat parts according to site type; calculated using NISP frequencies for those bones which comprise each category. Data derive from Appendix 17.

Site Type (sample size)	Skeletal part category							
	Head		Primary		Secondary		Extremity	
	range	mean	range	mean	range	mean	range	mean
Rural (n=18)	18.5-72.9	**43.8**	0.0-30.7	**17.6**	4.9-37.0	**18.6**	10.5-39.5	**20.1**
Urban 1 (n=11)	20.4-54.8	**36.8**	5.4-36.2	**21.6**	7.6-29.7	**16.7**	10.3-45.2	**24.8**
Urban 2 (n=7)	12.5-67.0	**39.7**	6.5-24.9	**14.6**	8.1-27.3	**16.9**	12.3-49.0	**28.9**
Special (n=4)	19.2-66.7	**46.3**	1.2-31.7	**18.3**	11.1-31.2	**15.6**	5.0-36.9	**19.8**

TABLE 63

Sheep/goat parts mean frequencies as standardized statistic for site type. Data derive from Table 62 and Appendix 17.

Site type (sample size)	Skeletal part category			
	Head	Primary	Secondary	Extremity
Rural (n=18)	4.9	4.4	4.7	4.0
Urban1 (n=11)	4.1	5.4	4.2	5.0
Urban2 (n=7)	4.4	3.7	4.2	5.8
Special (n=4)	5.1	4.6	3.9	4.0

TABLE 64

Sheep/goat parts mean frequencies as standardized statistic for geographic area and site type. Data derive from Appendix 17.

Region/site type (sample size)	**Skeletal part category**			
	Head	**Primary**	**Secondary**	**Extremity**
SOUTHERN ITALY				
rural (n=6)	4.9	3.4	4.5	4.8
urban1 (n=1)	2.3	4.6	5.6	7.8
urban2 (n=1)	1.3	2.9	6.8	9.8
special (n=1)	4.5	5.9	4.9	3.2
ALL TYPES (n=9)	**4.2**	**3.7**	**4.9**	**5.5**
CENTRAL ITALY				
rural (n=10)	4.6	5.2	5.1	3.6
urban1 (n=8)	4.3	6.3	4.4	3.7
urban2 (none)				
special (n=2)	7.0	2.2	3.9	2.6
ALL TYPES (n=20)	**4.7**	**5.3**	**4.7**	**3.5**
NORTHERN ITALY				
rural (n=2)	6.2	3.5	2.7	3.9
urban1 (n=2)	4.2	2.2	2.4	8.8
urban2 (n=6)	4.9	3.8	3.8	5.1
special (n=1)	2.1	7.9	3.3	5.8
ALL TYPES (n=11)	**4.8**	**3.8**	**3.3**	**5.8**

TABLE 65

Sheep/goat parts mean frequencies as standardized statistic for temporal period. Data derive from Appendix 17.

Period (sample size)	**Skeletal part category**			
	Head	**Primary**	**Secondary**	**Extremity**
Period 1 (n=12)	4.0	4.6	4.9	5.2
Period 2 (n=9)	4.5	4.7	3.9	5.0
Period 3 (n=19)	5.0	4.5	4.3	4.0

TABLE 66

Range and mean frequency of pig parts according to site type; calculated using NISP frequencies for those bones which comprise each category. Data derive from Appendix 18.

Site type (sample size)	Skeletal part category							
	Head		Primary		Secondary		Extremity	
	range	mean	range	mean	range	mean	range	mean
Rural (n=17)	34.5-85.5	**57.2**	3.5-28.9	**14.4**	2.0-21.0	**11.2**	1.6-39.7	**17.2**
Urban1 (n=15)	25.9-67.1	**47.7**	11.1-33.5	**20.5**	4.1-33.3	**14.5**	4.3-30.7	**17.3**
Urban2 (n=6)	17.9-66.7	**43.8**	7.5-36.7	**18.4**	8.2-22.4	**13.9**	0.0-52.2	**23.9**
Special (n=4)	53.2-77.1	**64.6**	8.8-21.2	**12.5**	5.7-22.5	**10.1**	8.4-17.3	**12.8**

TABLE 67

Pig parts mean frequencies as standardized statistic for site type. Data derive from Table 66 and Appendix 18.

Site type (sample size)	**Skeletal part category**			
	Head	**Primary**	**Secondary**	**Extremity**
Rural (n=17)	4.8	3.6	2.8	2.9
Urban1 (n=15)	4.0	5.1	3.6	2.9
Urban2 (n=6)	3.7	4.6	3.5	4.0
Special (n=4)	5.4	3.1	2.5	2.1

TABLE 68

Pig parts mean frequencies as standardized statistic for geographic area and site type. Data derive from Appendix 18.

Region/Site type (sample size)	Skeletal part category			
	Head	Primary	Secondary	Extremity
SOUTHERN ITALY				
rural (n=4)	4.9	2.2	2.2	3.9
urban1 (n=1)	4.0	4.2	3.3	3.7
urban2 (n=1)	1.5	1.9	5.6	8.7
special (n=1)	4.4	2.7	5.6	2.3
ALL TYPES (n=7)	**4.2**	**2.5**	**3.4**	**4.3**
CENTRAL ITALY				
rural (n=11)	4.7	4.2	3.0	2.5
urban1 (n=12)	4.0	5.3	3.7	2.7
urban2 (none)				
special (n=2)	6.3	2.3	1.4	2.5
ALL TYPES (n=25)	**4.5**	**4.6**	**3.2**	**2.5**
NORTHERN ITALY				
rural (n=2)	5.1	2.8	2.8	2.7
urban1 (n=2)	3.7	4.7	3.5	3.8
urban2 (n=5)	4.1	5.1	3.1	3.0
special (n=1)	4.6	5.3	1.6	2.9
ALL TYPES (n=10)	**4.3**	**4.6**	**2.9**	**3.1**

TABLE 69

Pig parts mean frequencies as standardized statistic for temporal period. Data derive from Appendix 18.

Period (sample size)	Skeletal part category			
	Head	Primary	Secondary	Extremity
Period 1 (n=11)	4.0	4.6	3.5	3.4
Period 2 (n=12)	4.2	4.0	2.9	3.7
Period 3 (n=19)	4.7	4.2	3.1	2.3

Map #	Site	P	T
1	Altino	3	u1
2	Aquileia	2	sp
3	Campochiaro	3	sp
4	Cantone	2	sp
5	Capaccio	1	sp
6	Capua, Carillo	2,3	u1
58	Classe	3	
7	Colognola	1	u2
8	Cosa	2	u1
9	Cozzo Presepe	1	u2
10	Gravetta	1	sp
11	Gravina	1	r
12	Hipponion-Vibo Valentia	1	sp
13	Innichen	2	u2
14	Invillino-Ibligo	2,3	u2
15	Kaulonia	1	u1
16	Le Colonne	2	r
17	Locri	1	sp
18	Lomello	3	r
19	Lugnano	2,3	r/sp
20	Luni	2,3	u1
21	Matrice	2,3	r
22	Metaponto area, kiln	1	u2
	Metaponto area, Pizz.	1	u2
23	Modena	2	u1
24	Monte Barro	3	r
25	Monte Gelato	2,3	r
26	Monte Irsi	1	r
27	Montereale	3	sp
59	Naniglio		
28	Naples, Carminiello	1,2,3	u1
	Naples, Girolamini	3	u1
	Naples, S. Patrizia	3	u1
	Naples, Santa Maria la Nova	3	u1
	Naples, Santa Sofia	2	u1
	Naples, Via San Paolo	3	u1
29	Narce	1	r
30	Oppido Lucano	2	r
31	Ossaia, Cortona	1,2	r
32	Ostia, bath	2,3	u1
	Ostia, castrum	1,2	u1
33	Otranto	1,3	u1
34	Palazzo Dugentesco	2	u2
35	Pistoia	2,3	u1
36	Pompeii 94	1	u1
	Pompeii 95	1	u1
	Pompeii, forum	1,2	u1
	Pompeii, Ganimede	1	u1
	Pompeii, gardens	2	u1
37	Populonia	1	u1
38	Pozzuolo del Friuli	1	u2
39	Quintili	2	r
40	Roccagloriosa	1	u2/sp
41	Rome, Forum Transitorium	2	u1
	Rome, Meta Sudans	3	u1
	Rome, San Omobono	1	u1/sp
	Rome, Schola Praeconum	3	u1
42	Saepinum	2	u1
43	San Biago	2,3	r
44	San Costanzo	2	r
45	San Giacomo	3	r
46	San Giovanni	2,3	r
47	San Giovenale	1	r/sp
48	San Potito	2	r
49	Settefinestre	1,2,3	r
50	Spina	1	u1
51	Stufels	2	u2
52	Torcello	2	u2
53	Udine	3	u2
54	Vaste	1	r/sp
55	Via Gabina	2,3	r
56	Villa Clelia	3	u2
57	Volano	2,3	sp

P = temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

FIGURE 1

Location of Sites

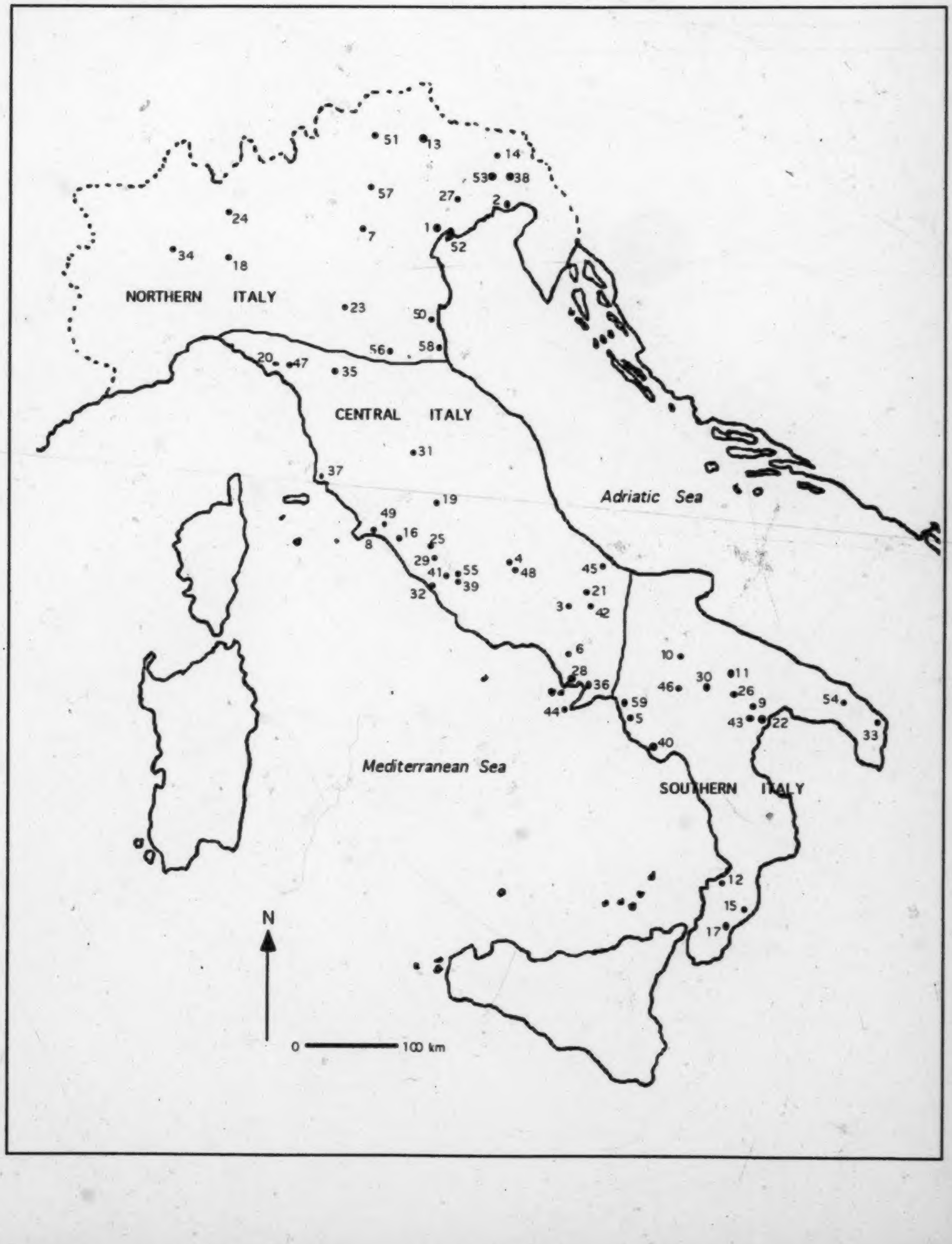
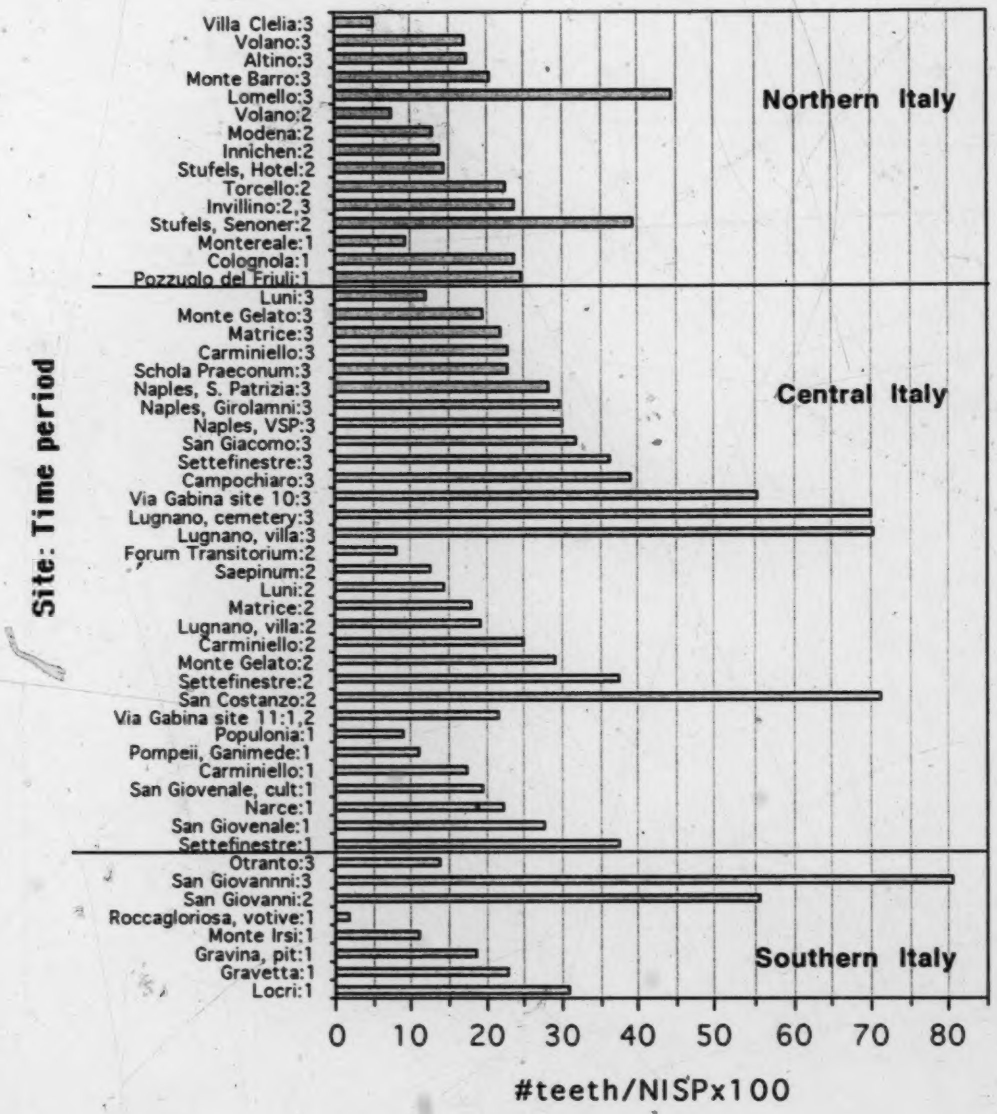

51
13
14
53
38
57
27
2
24
1
7
52
34
18
NORTHERN ITALY
23
50
56
58
20
47
35
CENTRAL ITALY
31
37
19
Adriatic Sea
49
16
25
8
29
4
45
41
55
48
39
32
21
3
42
6
10
28
30
11
36
46
26
59
9
54
44
5
43
22
33
40
Mediterranean Sea
SOUTHERN ITALY
12
15
17
N
0
100 km

FIGURE 2

#teeth/NISPx100 figures for Roman period sites in Italy. Based on data in Table 12.



Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity

FIGURE 3

Frequency of Roman period sites in Italy with recovered animal bones according to NISP sample sizes. Based on data from Table 13.

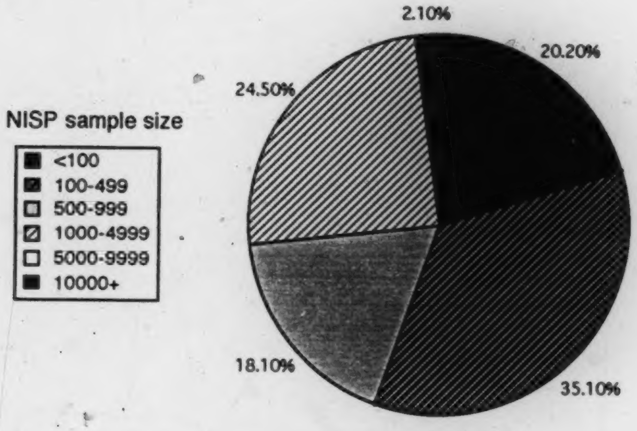


FIGURE 4

Number of sites per NISP sample size category and site type. Based on data from Table 13.

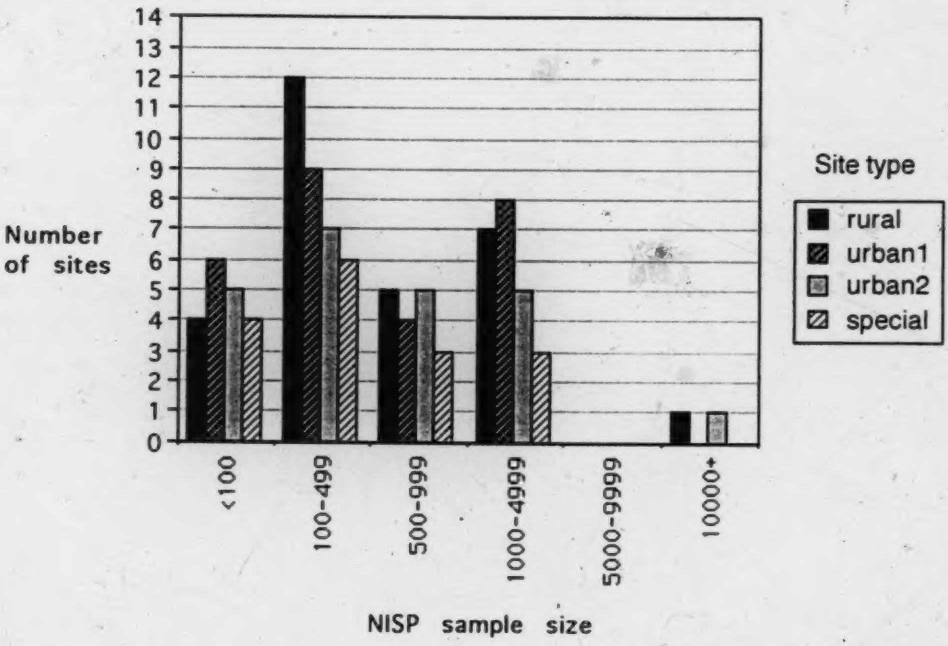


FIGURE 5

Number of sites per NISP sample size category and region. Based on data from Table 13.

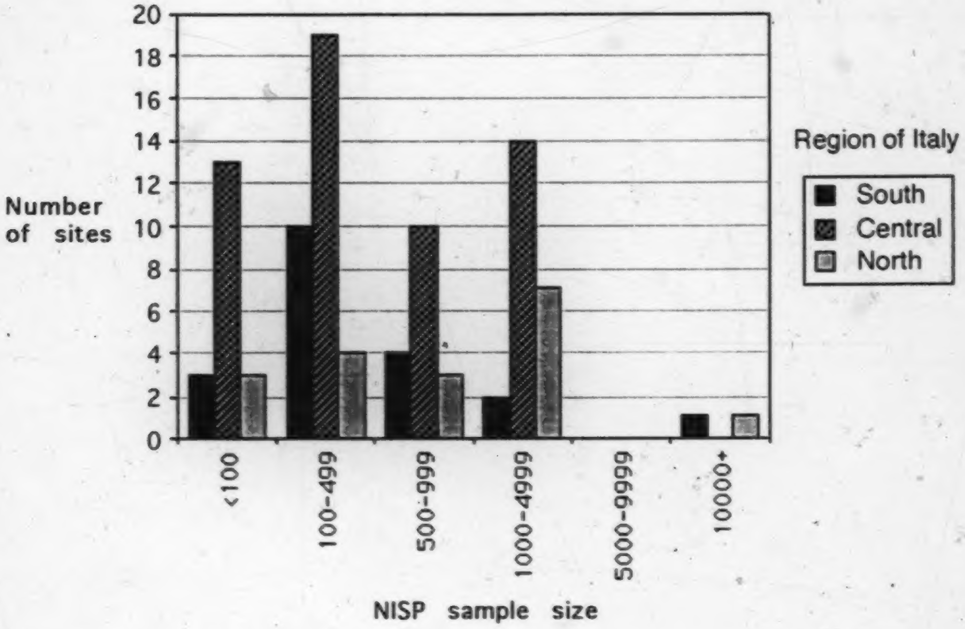


FIGURE 6

Number of sites per NISP sample size category and time period. Based on data from Table 13.

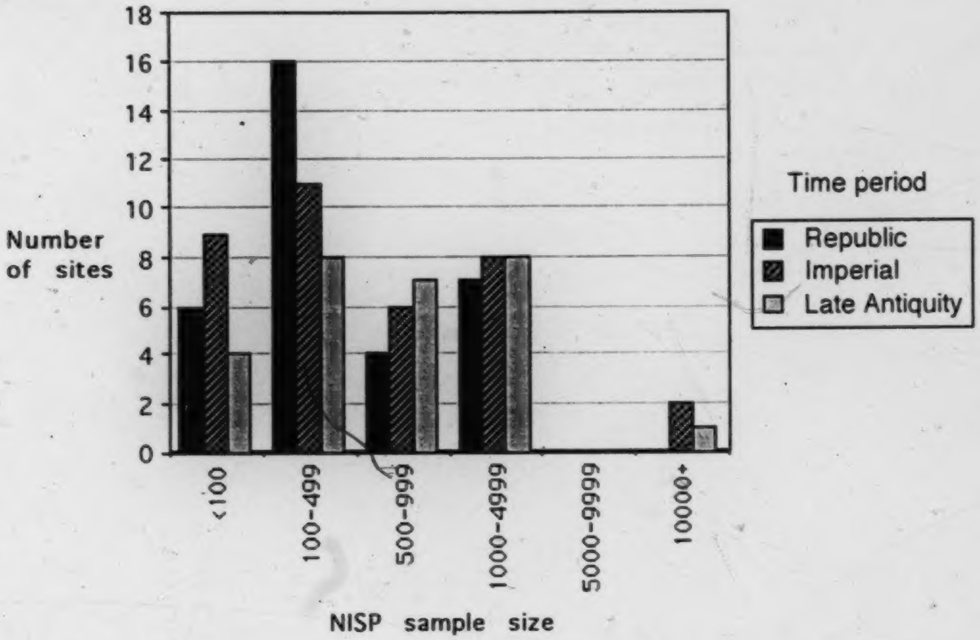
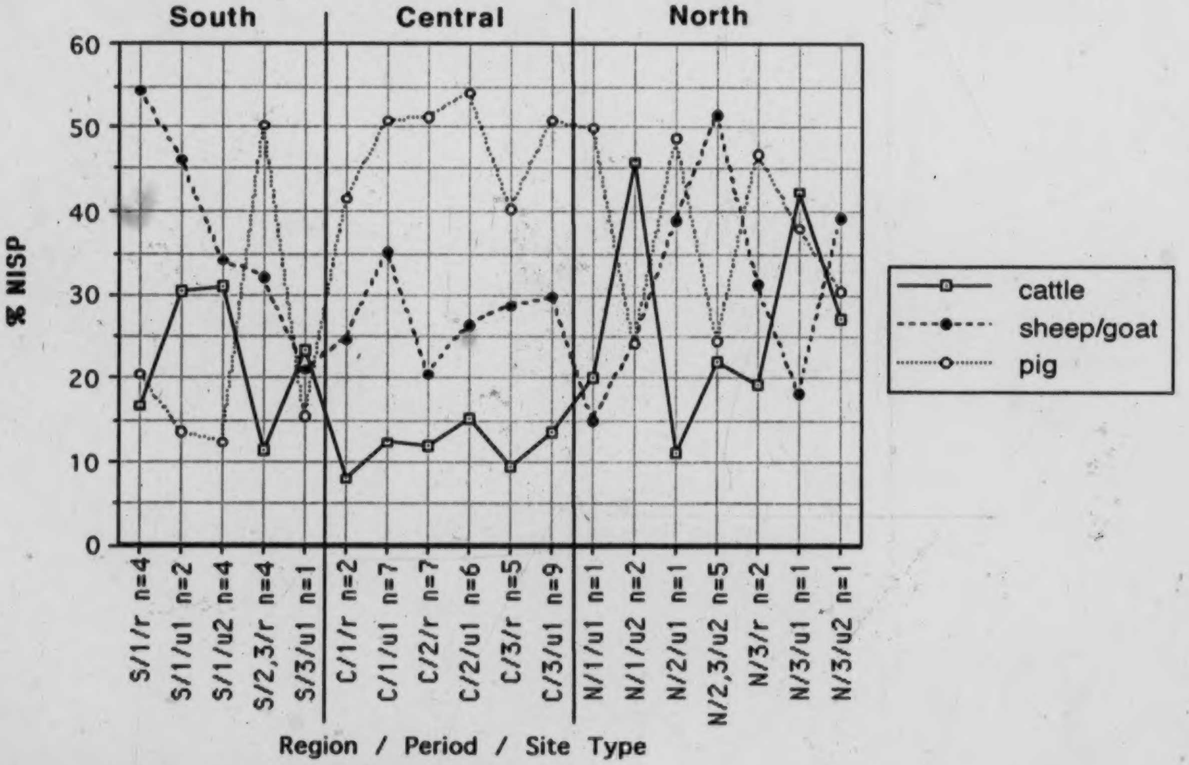


FIGURE 7

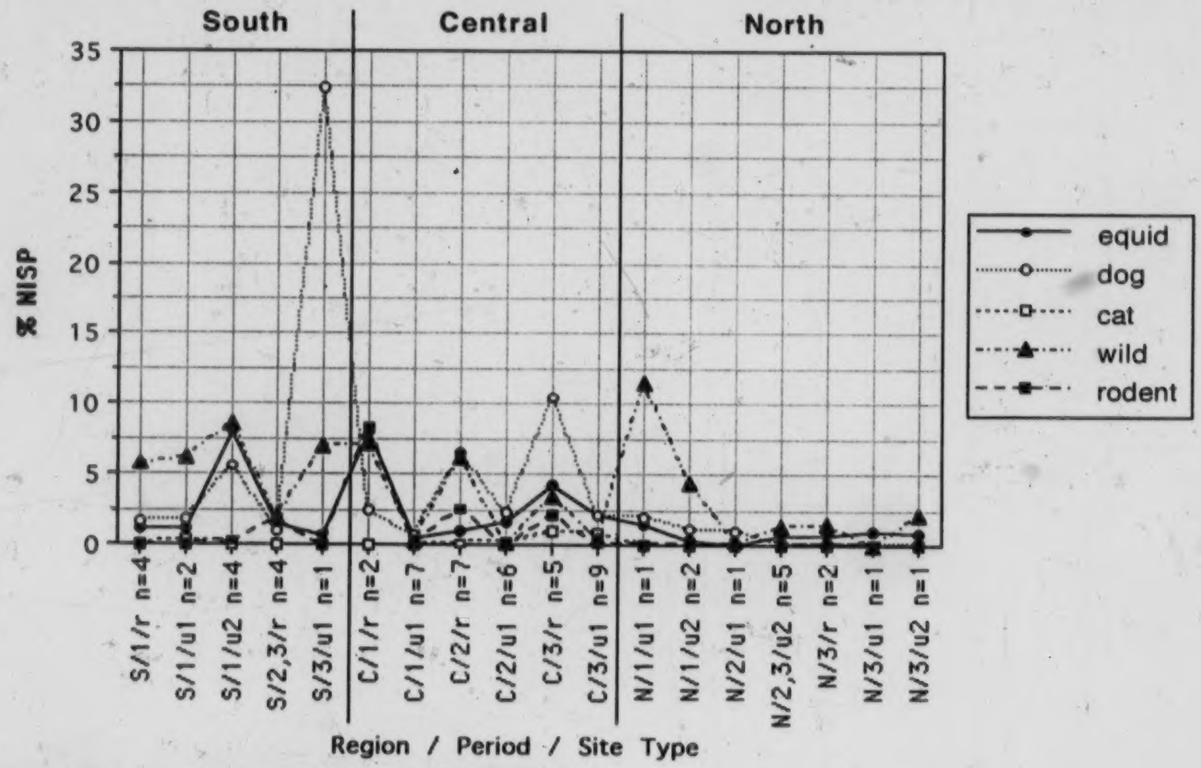
Mean NISP frequencies for cattle, sheep/goat, and pig among Roman period sites in Italy. Data derive from Table 16.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 8

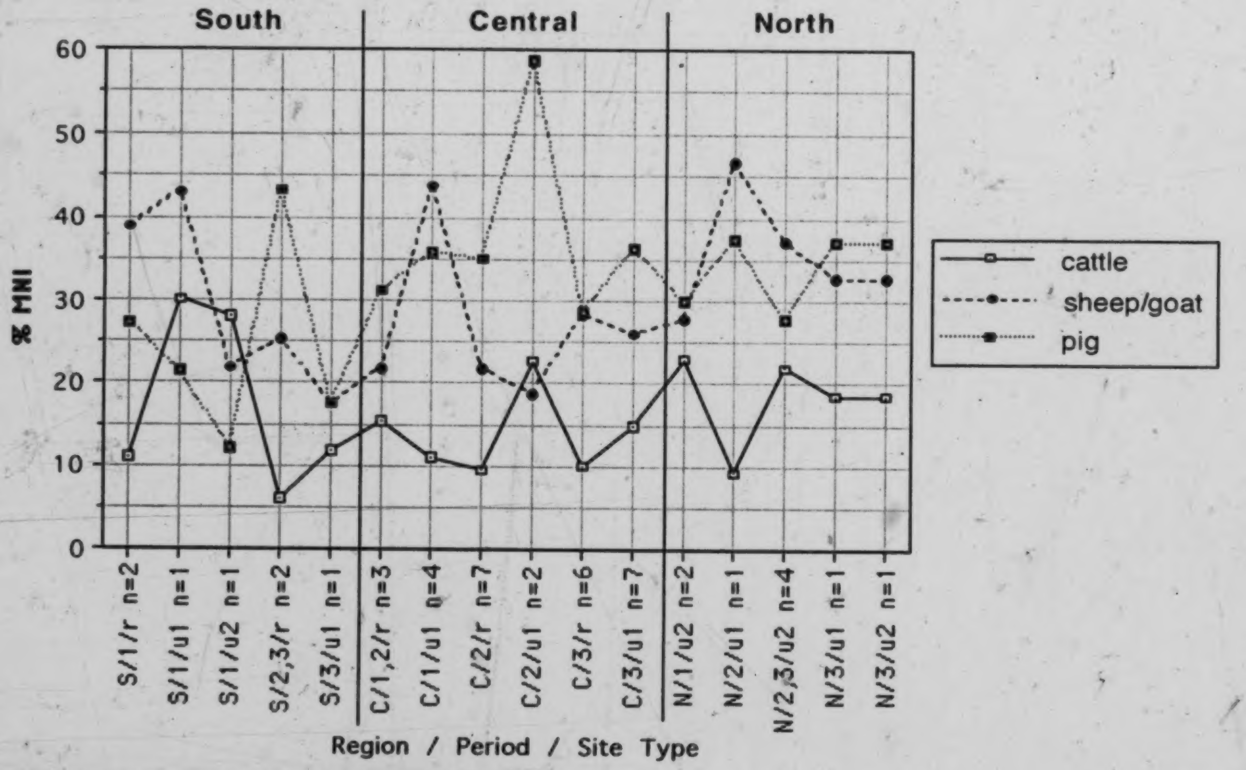
Mean NISP frequencies for equids, dogs, cats, wild animals, and rodents among Roman period sites in Italy. Data derive from Table 16.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 9

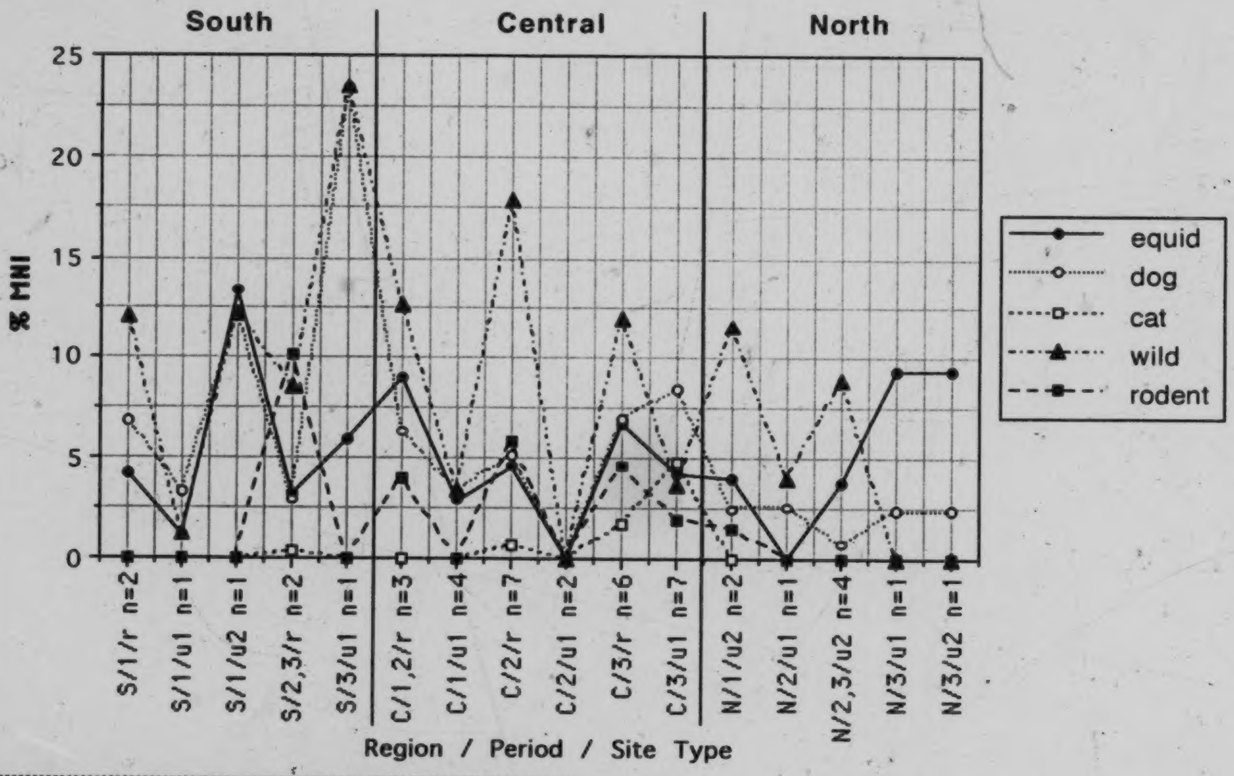
Mean MNI frequencies for cattle, sheep/goat, and pig according to geographic region/time period/site type categories. Data derive from Table 17.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 10

Mean MNI frequencies for equids, dogs, cats, wild animals, and rodents according to geographic region/time period/site type categories. Data derive from Table 17.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 11

Cattle: NISP and MNI mean frequencies by site type. Data derive from Tables 18 and 19.

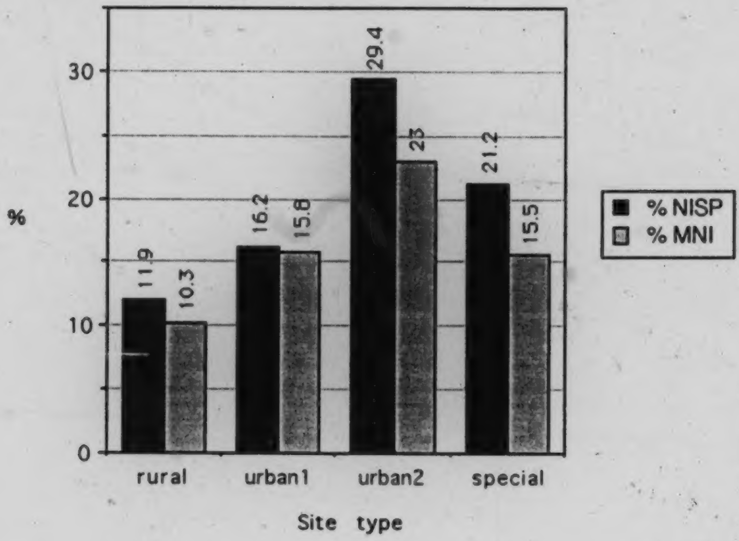
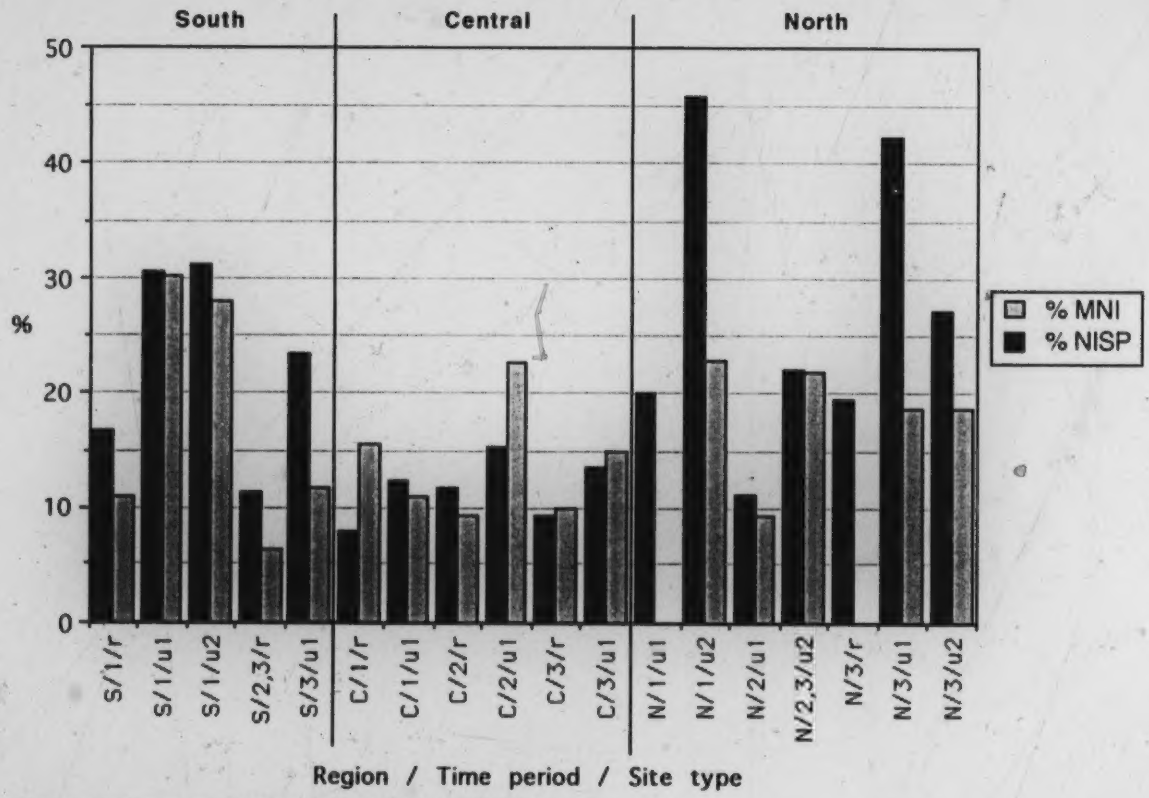


FIGURE 12

Cattle: NISP and MNI frequencies by geographic area, time period, and site type. Data derive from Tables 16 and 17.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 13

Cattle metacarpal Bd measures from Period 1.

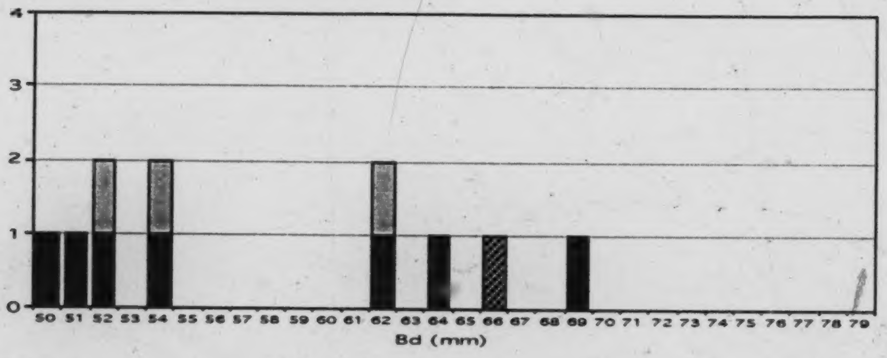


FIGURE 14

Cattle metacarpal Bd measures from Period 2.

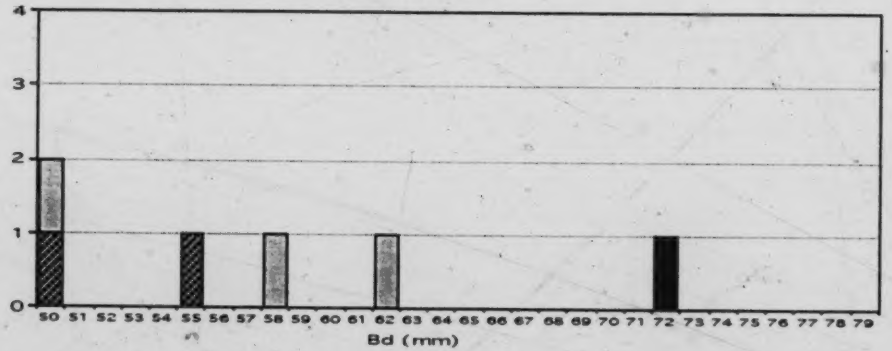


FIGURE 15

Cattle metacarpal Bd measures from Period 3.

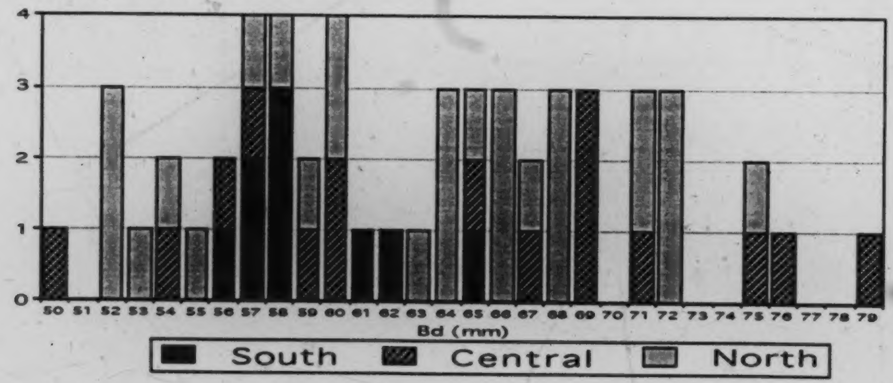


FIGURE 16

Cattle metatarsal Bd measures from Period 1.

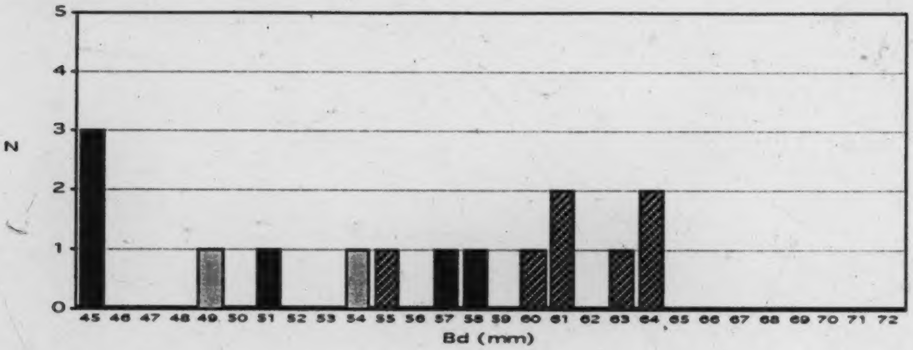


FIGURE 17

Cattle metatarsal Bd measures from Period 2.

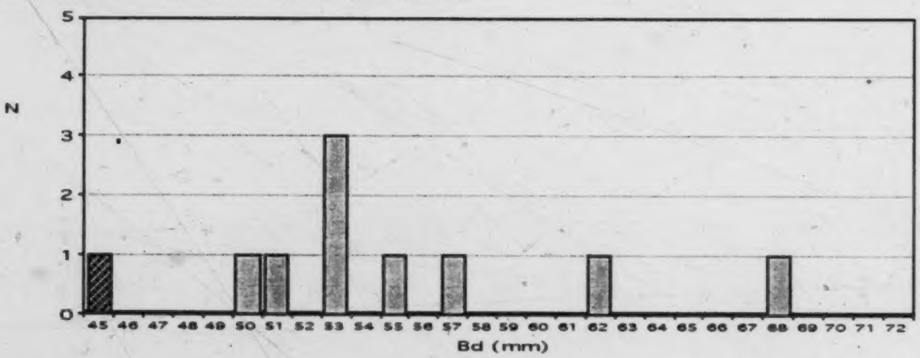


FIGURE 18

Cattle metatarsal Bd measures from Period 3.

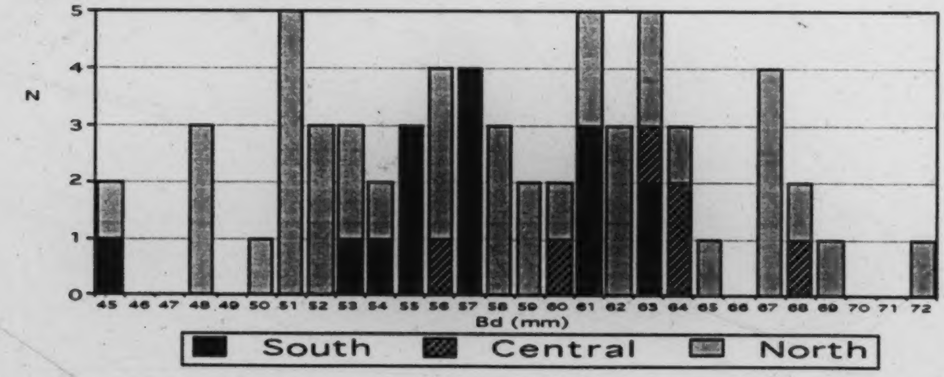


FIGURE 19

Sheep/goat: NISP and MNI mean frequencies by site type. Data derive from Tables 18 and 19.

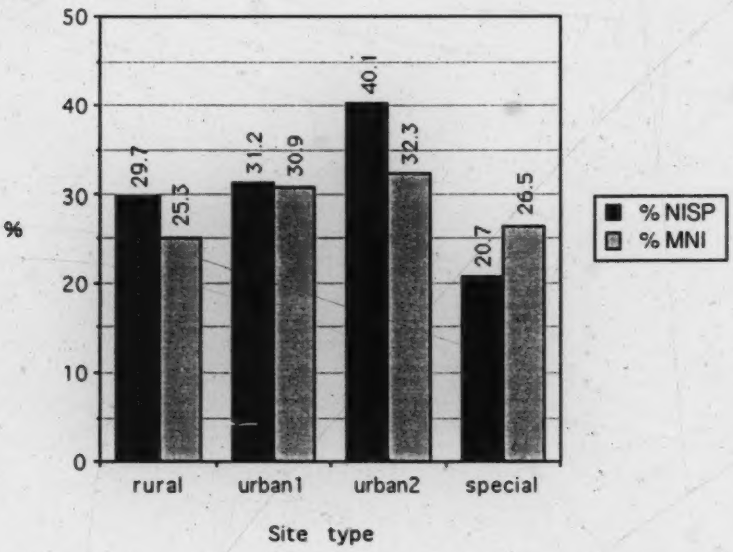
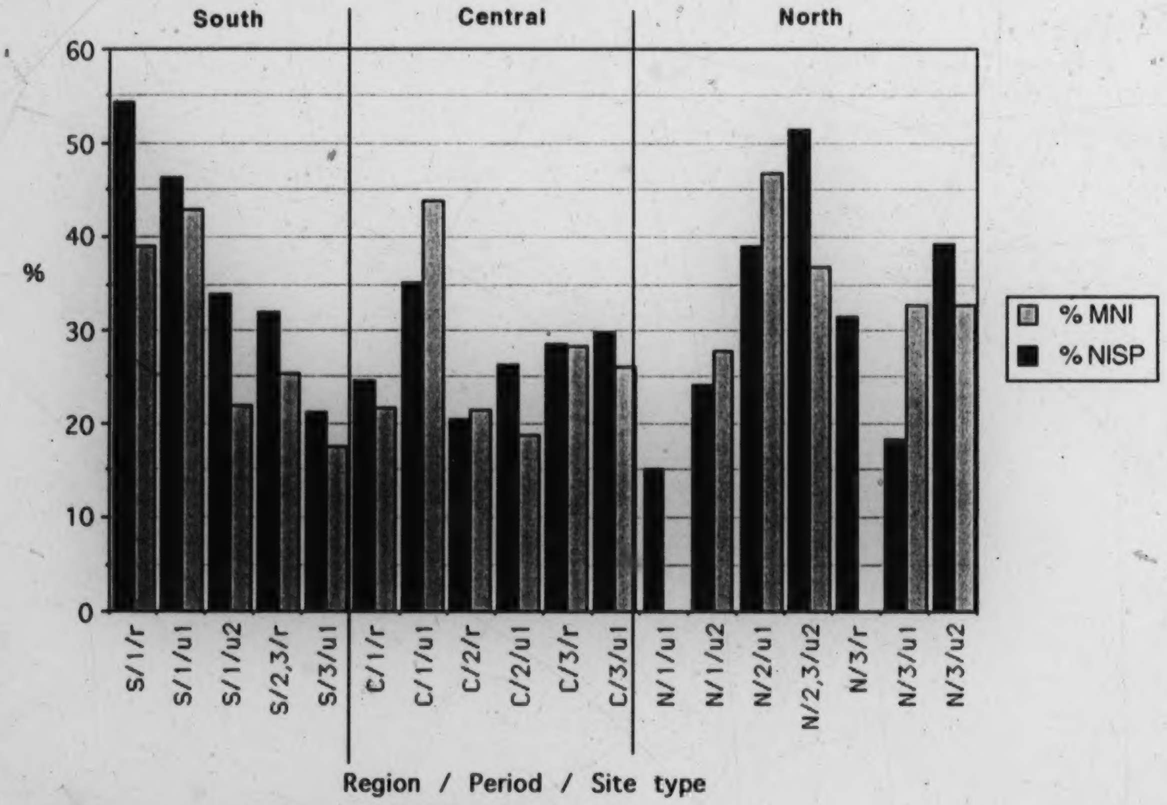


FIGURE 20

Sheep/goat: NISP and MNI frequencies by geographic area, time period, and site type. Data derive from Tables 16 and 17.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 21

Pig: NISP and MNI mean frequencies by site type. Data derive from Tables 18 and 19.

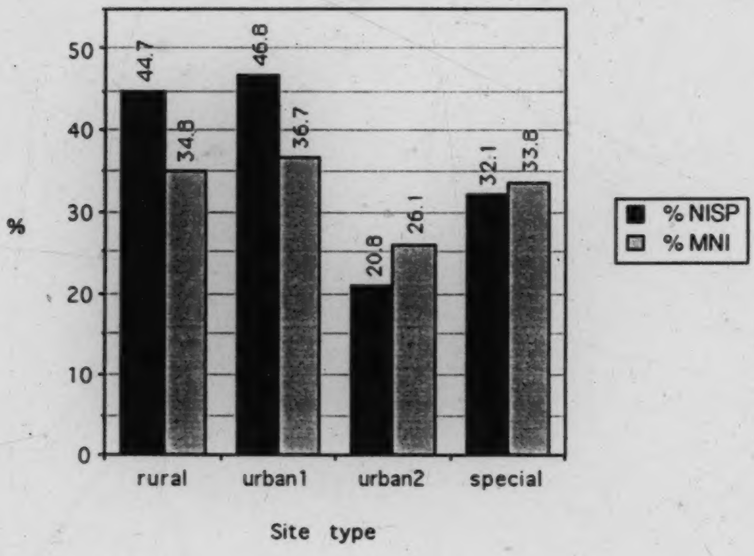
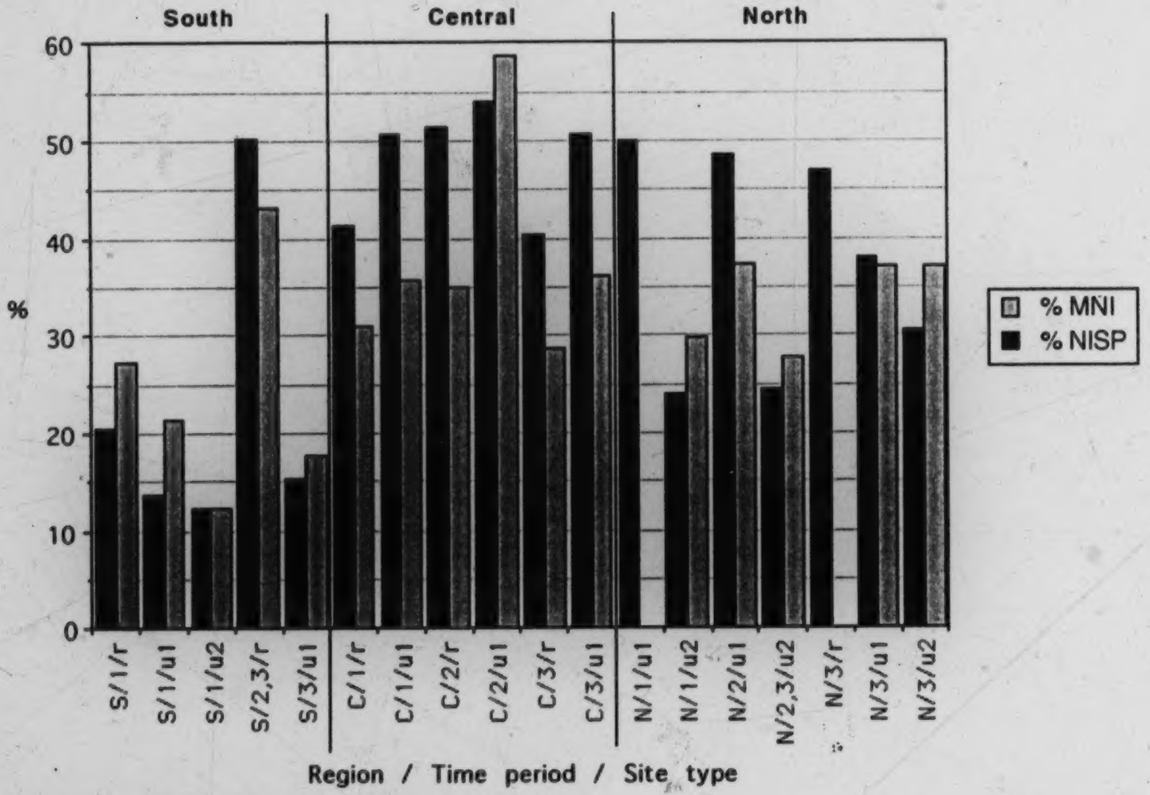


FIGURE 22

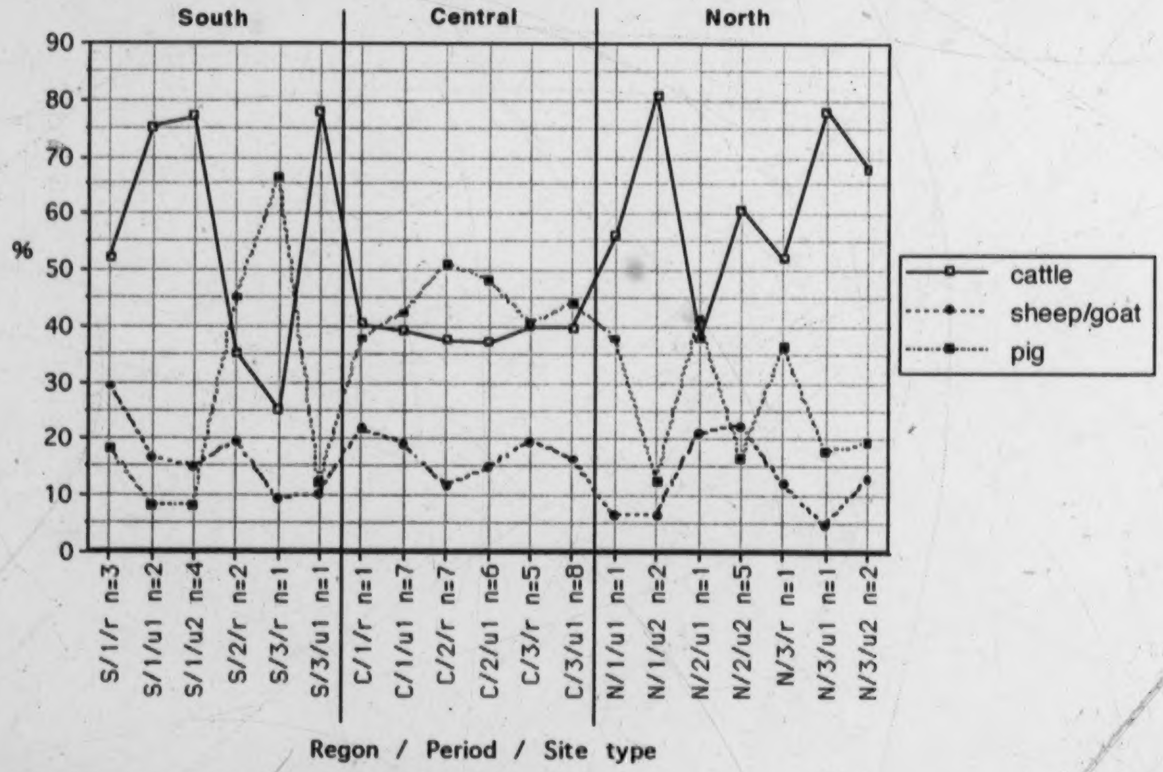
Pig: NISP and MNI frequencies by geographic area, time period, and site type. Data derive from Tables 16 and 17.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 23

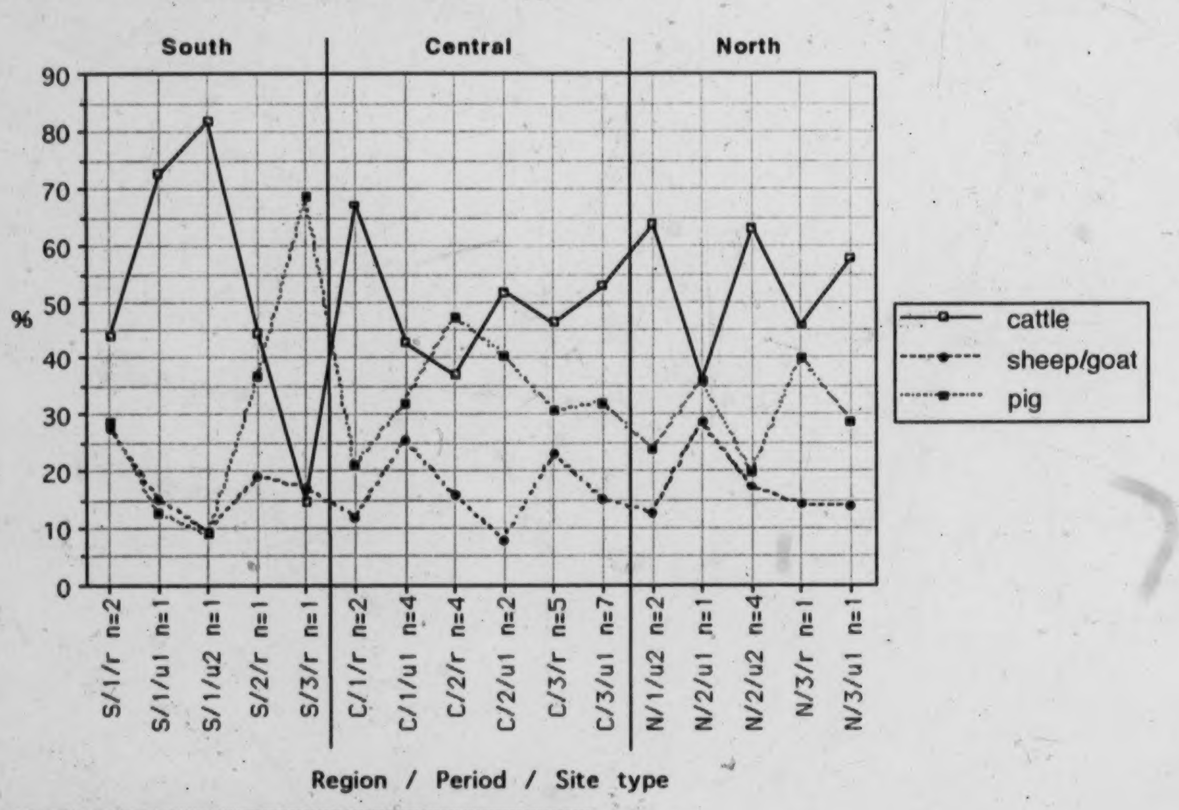
Mean meat weight frequencies of cattle, sheep/goat, and pig according to geographic region/temporal period/site type groups; calculated on the basis of NISP values. Data derive from Appendix 14.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

FIGURE 24

Mean meat weight frequencies of cattle, sheep/goat and pig according to geographic region/temporal period/site type groups; calculated on the basis of MNI values. Data derive from Appendix 13.



Geographic region: S = southern Italy; C = central Italy; N = northern Italy
Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement)

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Appendix 1

Type of text, author and works, and value of that work in terms of animal references for several kinds of ancient texts.

Type of text	Author and works	Value for animal references
agricultural manual	• Cato (*De agri cultura*) • Varro (*Res rustica*) • Columella (*De re rustica*) • Virgil (*Georgics*) • Palladius (*De re rustica* or *Opus agriculturae*)	- "textbook" style of writing, therefore "practical objective" to works (i.e. instruct/inform about farming) - abundant information especially about animal husbandry, breeding and maintenance on the farm -assumed reliable, but some controversy distinguishing between prescriptive (or ideal) and descriptive (or actual) practice
encyclopedia	• Pliny the Elder (*Naturalis Historia*) • Aelian (*De natura animalium*) • Strabo (*Geographica*)	- "textbook" style of writing - numerous observations and "facts" about animals - assumed reliable, but some anecdotes obviously unrealistic
scientific poetic manual	• Celsus (*Artes* or *De medicina*)	- incidental references to animals, notably medicinal and scientific application - assumed reliable
philosophical treatise	• Lucretius (*De re natura*)	- incidental references to animals
cookbook	• Apicius (*De re coquinaria*)	- recipes, primarily for an elite market, with some information about general Roman diet
comedy	• Plautus (various comedies) • Terence (various comedies)	- often includes comments about food or animals, and makes numerous animal analogies - incidental food references assumed to reflect actual practice
pastoral poetry	• Virgil (*Eclogues*) • Calpurnius (*Eclogues*) • Nemesianus (*Eclogues*) • Virgil (*Eclogues*)	- many animal references - idealized representation of country life, but based on real world - reliable when considered with prudence and stripped of literary embellishment
hunting poetry	• Grattius (*Cynegetica*) • Nemesianus (*Cynegetica*)	- references about wild animals, and dogs and horses (used in hunting) - both instructive and descriptive - reliable and informative but generally restricted to hunting context
instructive poetry	• Macrobius (*Saturnalia*)	- instructional objective to writing which is, in some measure, overshadowed by need to create a literary "experience" for the reader - fairly reliable source of animal information - beneath poetic exterior lies foundation of veracity and accuracy
elegy/epigram	• Tibullus (*Elegia*) • Propertius (*Elegia*) • Martial (*Epigrammata*) • Ovid (*Fasti*)	- popular poetic means of expressing personal thoughts and feelings - numerous references to animals, especially in relation to food, sacrifice, natural settings and animal analogies for characters - food and sacrifice notes assumed reliable when considered without poetic decoration and in context
satire	• Horace (*Satires*) • Juvenal (*Satires*) • Persius (*Satires*)	- contains much information about animal resources, diets and urban/rural life - however, largely presents extremes interlaced with a moral message - fairly reliable when compensation made for satirical presentation
lyrical poetry	• Horace (*Odes* or *Carmina*, *Epodes*)	- incidental mention of animals - assumed reliable
letters	• Pliny the Younger (*Epistulae*) • Cassiodorus (*Variae epistulae*) • Horace (*Epistulae*) • Sidonius Apollinaris (*Epistulae*) • Fronto (*Epistulae*)	- incidental mention of animals - assumed to be fairly accurate information presented, but must be considered in light of significance of matter discussed, the audience and their anticipated reaction
novel	• Petronius (*Satyricon*)	- numerous references to food - some obviously exaggerated but all, nonetheless, based on some less grandiose truth - fairly reliable when literary embellishments peeled off
legal code	• Theodosian Code • Justinianic Code	- few animal references - reliable material, but restricted - context generally limited, either to religious aspects, such as animal sacrifice, or legal aspects, such as ownership, cost, trade and transport of animal resources
inscription	• Edict of Diocletian • numerous other examples and forms such as commemorative plaques, dedications, epitaphs, military diplomas, public notices and even graffiti	- animal references rare - those available primarily relate to aspects of animal sacrifice, trade, or cost of goods - assumed to be reliable information

Appendix 2

Number of mammal species (NS), number of identified mammalian specimens (NISP) and their ratio from Roman sites in Italy. Rodent species (i.e., mice, rats, voles) are not included in either count. However, dormice are included. Samples with less than 200 specimens are in parentheses. * denotes approximated value. The sites are arranged according to geographic region, time period, and site type.

SITE	Region	Period	Site type	NS	NISP	NS/NISP
Monte Irsi	S	1	r	(5)	(162)	(0.031)
Gravina, pit	S	1	r	9	316	0.028
Gravina (Watson)	S	1	r	16	757	0.021
Gravina (MacKinnon)	S	1	r	12	1208	0.010
Vaste	S	1	r/sp	7	208	0.034
Capacci	S	1	sp	(3)	(46)	(0.065)
Roccagloriosa, votive	S	1	sp	(2)	(62)	(0.032)
Gravetta	S	1	sp	(8)	(99)	(0.081)
Naniglio	S	1	sp	(2)	(104)	(0.019)
Locri	S	1	sp	6	397	0.015
Hipponion-Vibo Valentia	S	1	sp	(2)	(133)	(0.015)
Otranto	S	1	u1	9	602	0.015
Kaulonia	S	1	u1	9	751	0.012
Cozzo Presepe	S	1	u2	12	334*	0.036
Metaponto area, Pizz.	S	1	u2	8	355	0.023
Metaponto area, kiln	S	1	u2	8	493	0.016
Roccagloriosa	S	1	u2	12	1787	0.007
Oppido Lucano	S	2	r	9	431	0.021
San Giovanni	S	2,3	r	19	10941	0.002
San Biago	S	2,3	r	8	236	0.034
Otranto	S	3	u1	7	291	0.024
San Giovenale	C	1	r	(7)	(52)	(0.135)
Narce	C	1	r	(5)	(83)	(0.060)
Settefinestre	C	1	r	10	2579	0.004
San Giovenale, cult	C	1	sp	(5)	(39)	(0.128)
Ostia, castrum	C	1	u1	(4)	(125)	(0.032)
Pompeii 95	C	1	u1	(5)	(148)*	(0.034)
Pompeii, Ganimede	C	1	u1	9	909	0.010
San Omobono	C	1	u1/sp	4	2080	0.002
Carminiello	C	1	u1	6	2378	0.003
Pompeii, forum	C	1	u1	13	2600*	0.005
Populonia	C	1	u1	9	2014	0.004
Via Gabina, site 11	C	1,2	r	(5)	(95)	(0.053)
San Costanzo	C	2	r	(2)	(34)	(0.059)
Lugnano, villa	C	2	r	(8)	(39)	(0.205)
Quintili	C	2	r	(2)	(132)	(0.015)
San Potito	C	2	r	13	311	0.042
Monte Gelato	C	2	r	8	527	0.015
Le Colonne	C	2	r	8	547	0.015
Matrice	C	2	r	8	894	0.009
Settefinestre	C	2	r	14	898	0.016
Cantone	C	2	sp	3	824	0.004
Saepinum	C	2	u1	(3)	(39)	(0.077)
Capua, Carillo	C	2	u1	(4)	(46)	(0.087)
Naples, Santa Sofia	C	2	u1	(3)	(46)	(0.065)
Forum Transitorium	C	2	u1	(4)	(72)	(0.056)
Ostia, castrum	C	2	u1	(4)	(107)	(0.037)
Pompeii, gardens	C	2	u1	(12)	(195)*	(0.062)
Carminiello	C	2	u1	6	236	0.025
Pompeii, forum	C	2	u1	5	504*	0.010
Ostia, bath	C	2	u1	10	2566	0.004
Cosa lagoon	C	2	u1	(5)	(27)	(0.185)
Luni	C	2	u1	(4)	(106)	(0.038)
Pistoia	C	2	u1	(7)	(26)	(0.269)
Lugnano, villa	C	3	r	(6)	(40)	(0.150)
Settefinestre	C	3	r	12	222	0.054
San Giacomo	C	3	r	12	436	0.028
Monte Gelato	C	3	r	8	493	0.016
Matrice	C	3	r	8	689	0.012
Via Gabina, site 10	C	3	r	8	1668	0.005

Geographic regions: S = southern Italy; C = central Italy; N = northern Italy
Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site types: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

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Appendix 2 (continued)

Number of mammal species (NS), number of identified mammalian specimens (NISP) and their ratio from Roman sites in Italy. Rodent species (i.e., mice, rats, voles) are not included in either count. However, dormice are included. Samples with less than 200 specimens are in parentheses. * denotes approximated value. The sites are arranged according to geographic region, time period, and site type.

SITE	Region	Period	Site type	NS	NISP	NS/NISP
Campochiaro	C	3	sp	7	652	0.011
Lugnano, cemetery	C	3	sp	11	787	0.014
Capua, Carillo	C	3	u1	(4)	(42)	(0.095)
Naples, Santa Maria la Nova	C	3	u1	(4)	(72)	(0.056)
Ostia, bath	C	3	u1	(6)	(151)	(0.040)
Naples, Via San Paolo	C	3	u1	(6)	(176)	(0.034)
Naples, S. Patrizia	C	3	u1	6	560	0.011
Naples, Girolamini	C	3	u1	8	741	0.011
Rome, Schola Praeconum	C	3	u1	7	1614	0.004
Rome, Meta Sudans	C	3	u1	15	2451	0.006
Carminiello	C	3	u1	10	2330	0.004
Luni	C	3	u1	8	547	0.015
Pistoia	C	3	u1	3	247	0.012
Pozzuolo del Friuli	N	1	u2	6	276	0.022
Colognola	N	1	u2	10	2018	0.005
Montereale	N	1	sp	4	1164	0.003
Volano	N	2	sp	5	218	0.023
Aquileia	N	2	sp	1	601*	0.002
Modena	N	2	u1	7	1328	0.005
Palazzo Dugentesco	N	2	u2	(4)	(44)	(0.091)
Torcello	N	2	u2	(5)	(76)	(0.066)
Innichen	N	2	u2	10	740	0.014
Stufels - Hotel	N	2	u2	9	1155	0.008
Stufels - Senoner	N	2	u2	8	1551	0.005
Invillino-Ibligo	N	2,3	u2	16	22203	0.001
Lomello	N	3	r	4	354	0.011
Monte Barro	N	3	r	10	1299	0.008
Volano	N	3	sp	(6)	(106)	(0.057)
Altino	N	3	u1	5	732	0.007
Udine	N	3	u2	3	1056*	0.003
Villa Clelia	N	3	u2	(3)	(25)	(0.120)

Geographic regions: S = southern Italy; C = central Italy; N = northern Italy
Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
Site types: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 3

Cattle: Fusion data for individual sites.

Figures indicate the mean frequency of cattle younger than the specific age bracket. Sites are arranged according to geographic region, time period, and site type. The elements comprising each fusion age category are listed in Appendix 19.

Site	R	P	T	fusion sample size	Fusion age category			
					7-10 months	12-18 months	24-36 months	42+ months
Gravina, pit	S	1	r	2		0.0		0.0
Monte Irsi (3rd-2nd BC)	S	1	r	6		0.0	0.0	0.0
Monte Irsi (1st BC)	S	1	r	7		0.0	33.3	0.0
Gravina (7th-mid 2nd BC)	S	1	r	12	0.0	0.0	0.0	0.0
Gravina (2nd BC-1st AD)	S	1	r	76		0.0	35.7	33.3
Vaste (Republican)	S	1	r/sp	1		100.0		
San Giovanni	S	2	r	10		0.0	0.0	33.3
San Giovanni	S	3	r	243	0.0	0.0	22.4	19.5
Otranto	S	3	u1	25		8.3	25.0	22.2
Settefinestre	C	1	r	5	0.0	0.0		50.0
Via Gabina, site 11	C	1,2	r	4	0.0	0.0		
Populonia	C	1	u1	69	20.0	6.3	21.4	44.4
Lugnano, villa	C	2	r	1				100.0
Matrice (1st AD)	C	2	r	3		0.0		100.0
Matrice (2nd-3rd AD)	C	2	r	13		0.0	0.0	66.7
Settefinestre	C	2	r	63	0.0	3.7	33.3	0.0
Luni	C	2	u1	9		0.0	0.0	0.0
Matrice	C	3	r	7		0.0	0.0	0.0
San Giacomo	C	3	r	8	0.0	0.0		100.0
Via Gabina, site 10	C	3	r	30	0.0	9.5	33.3	
Settefinestre	C	3	r	43	25.0	9.5	66.7	14.3
Campochiaro	C	3	sp	4		0.0	50.0	
Lugnano, cemetery	C	3	sp	14	0.0	0.0	0.0	33.3
Naples, Via San Paolo	C	3	u1	4		0.0		33.3
Naples, Girolamini	C	3	u1	14		0.0	100.0	0.0
Luni	C	3	u1	29		0.0	0.0	21.4
Schola Praeconum	C	3	u1	39			12.1	100.0
Modena	N	2	u1	40	25.0	16.7	20.0	21.1
Monte Barro	N	3	r	22	0.0	7.7	33.3	25.0

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 4

Frequency of cattle in dental age classes at individual sites.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	Sample size	Dental age category								Technique
					0-6 months	6-12 months	15-18 months	18-24 months	24-30 months	>36 months	>48 months	>60 months	
Monte Irsi	S	1	r	2	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0	Silver
Cozzo Presepe	S	1	u2	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	Grant
San Giovanni	S	3	r	39	0.0	5.1	12.8	0.0	12.8	23.1	15.4	30.8	Grant
Narce	C	1	r	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	Silver
Matrice	C	1	r	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	Grant
Pompeii, Ganimede	C	1	u1	3	0.0	0.0	0.0	0.0	0.0	33.3	33.3	33.3	Silver
Populonia	C	1	u1	8	0.0	0.0	0.0	12.5	0.0	87.5	0.0	0.0	Silver (MNI)
Matrice	C	2	r	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	Grant
Forum Transitorium	C	2	u1	2	0.0	0.0	50.0	0.0	50.0	0.0	0.0	0.0	Grant
Via Gabina, site 10	C	3	r	12	8.3	0.0	0.0	0.0	0.0	16.7	50.0	25.0	Grant (NISP)
Matrice	C	3	r	2	50.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	Grant
Lugnano, cemetery	C	3	sp	11	0.0	0.0	0.0	0.0	18.2	27.3	36.4	18.2	Grant
Schola Praeconum	C	3	u1	7	0.0	0.0	0.0	14.3	0.0	14.3	71.4	0.0	Silver
Colognola	N	1	u2	15	6.7	6.7	6.7	0.0	20.0	13.3	20.0	26.7	Silver (MNI)
Pozzuolo del Friuli	N	1	u2	6	0.0	16.7	0.0	0.0	16.7	50.0	16.7	0.0	Silver (MNI)
Stufels - Senoner	N	2	u2	9	11.1	0.0	0.0	11.1	11.1	33.3	11.1	22.2	Silver
Stufels - Hotel	N	2	u2	8	0.0	12.5	0.0	25.0	0.0	25.0	12.5	25.0	Silver
Innichen	N	2	u2	5	0.0	0.0	40.0	0.0	20.0	0.0	40.0	0.0	Silver
Invillino	N	2,3	u2	37	2.7	2.7	0.0	0.0	10.8	21.6	27.0	29.7	Silver
Volano	N	2,3	sp	13	0.0	15.4	0.0	0.0	0.0	30.8	7.7	46.2	Silver
Monte Barro	N	3	r	2	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	Silver
Altino	N	3	u2	6	0.0	16.7	0.0	0.0	16.7	33.3	16.7	16.7	Silver

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial ; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

technique: Grant=using wear stages proposed by Grant (1982); Silver=using dental eruption criteria of Silver (1969)

Appendix 5

Frequency of cattle in various age categories for individual sites.

Sites are arranged according to geographic region, time period, and site type.

SITE	R	P	T	Aging Criterion	sample size for age categories	Age category					NOTES
						neonate	juvenile	subadult	adult	old age	
Locri	S	1	sp	dental	7		14.3	28.5	42.9	14.3	
Kaulonia	S	1	u1	na	198		0.5	9.6	89.9		
Roccagloriosa	S	1	u2	na	na		8.7	16.5	63.5	11.5	
Metaponto, Pizz.	S	1	u2	na	na			3.2	96.4		approx
San Giovenale	C	1	r	na	10			10	90.0		
San Giovenale, cult	C	1	sp	na	6				100.0		
San Omobono	C	1	u1/sp	na	9		22.2	22.2	55.6		
Pompeii 94	C	1	u1	na	na				most		
Pompeii 95	C	1	u1	na	na				most		
Carminiello	C	1-3	u1	na	na				nearly all		
Le Colonne	C	2	r	na	na				most		
Monte Gelato	C	2	r	na	na				most		
Pistoia	C	2,3	u1	na	na				all		
Monte Gelato	C	3	r	na	na				most		
Spina	N	1	u1	na	na				60.0		approx
Pozzuolo del Friuli	N	1	u2	na	na				most		
Aquileia	N	2	sp	horns	na		1.0	26.0	73.0		
Palazzo Dugentesco	N	2	u2	na	na				all		
Torcello	N	2	u2	na	na		15.0	10.0	most	most	approx
Lomello	N	3	r	na	na				all		
Udine	N	3	u2	na	na		34.6	23.1	42.3		MNI
Villa Clelia	N	3	u2	na	na				all		

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 6

Sheep/goat: Fusion data for individual sites.

Figures indicate the mean frequency of sheep/goat younger than the specific age category. Sites are arranged according to geographic region, time period, and site type. The elements comprising each fusion age category are listed in Appendix 19.

Site	R	P	T	fusion sample size	Fusion age category			
					under 12 months	14-36 months	47-48 months	48-60 months
Gravina (7th-mid 2nd BC)	S	1	r	25	11.1	22.2	100.0	60.0
Gravina (2nd BC-1st AD)	S	1	r	173	10.0	10.4	24.4	26.7
Gravina, pit	S	1	r	76	31.6	28.6	57.1	37.5
Monte Irsi (3rd-2nd BC)	S	1	r	5	0.0	33.3		
Monte Irsi (1st BC)	S	1	r	4	0.0	33.3		
Vaste (Hellenistic)	S	1	r/sp	1		0.0		
Vaste (Republican)	S	1	r/sp	5	50.0		0.0	100.0
Cozzo Presepe	S	1	u2	115	2.9	45.7	25.0	78.3
San Giovanni	S	2	r	3		0.0	100.0	
San Giovanni	S	3	r	338	21.1	16.7	27.7	41.2
Otranto	S	3	u1	32	0.0	9.1	50.0	33.3
Settefinestre	C	1	r	11	33.3	20.0	33.3	
Narce	C	1	r	4	0.0	33.3		
Via Gabina, site 11	C	12	r	3		100.0	0.0	100.0
Carminiello	C	12	u1	32	7.7	14.3	42.9	60.0
Populonia	C	1	u1	316	25.3	25.2	25.3	55.6
Settefinestre	C	2	r	50	22.2	15.8		50.0
Matrice (2nd-3rd AD)	C	2	r	18	100.0	80.0	100.0	75.0
Matrice (1st AD)	C	2	r	4	0.0			
Lugnano, villa	C	2	r	3	0.0	0.0		
Luni	C	2	u1	8	0.0	20.0		100.0
Via Gabina, site 10	C	3	r	114	31.8	35.3	58.3	80.0
Settefinestre	C	3	r	51	16.0	33.3	55.6	100.0
Matrice	C	3	r	47	44.4	72.2	85.7	66.7
San Giacomo	C	3	r	22	16.7	14.3	50.0	66.7
Lugnano, villa	C	3	r	1	0.0			
Campochiaro	C	3	sp	7	0.0	66.7		
Lugnano, cemetery	C	3	sp	7	0.0	33.3		66.7
Carminiello	C	3	u1	318	0.9	21.5	51.0	54.4
Schola Praeconum	C	3	u1	67	100.0	16.1		76.9
Naples, Girolamini	C	3	u1	38	50.0	20.0		
Luni	C	3	u1	21	12.5	44.4		75.0
Naples, Via San Paolo	C	3	u1	13	0.0	30.0		100.0
Naples, S. Patrizia	C	3	u1	12	33.3	66.7		33.3
Montereale	N	1	sp	162	2.7	15.0	35.1	25.0
Modena	N	2	u1	127	8.3	29.3	70.6	72.7
Monte Barro	N	3	r	64	30.0	37.2		63.6

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 7

Frequency of sheep/goat in dental age classes at individual sites.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	Sample size	Dental age category								Technique
					0-2 months	3-6 months	7-12 months	12-24 months	24-36 months	36-48 months	48+ months	72+	
Gravina, pit	S	1	r	12	33.3	41.7	0.0	0.0	0.0	25.0	0.0	0.0	Payne
Gravina	S	1	r	17	0.0	0.0	0.0	0.0	17.6	23.5	41.2	17.6	Grant/Payne
Monte Irsi	S	1	r	6			16.7	83.3					Silver
Locri	S	1	sp	8		12.5	12.5	25.0	25.0	25.0			Silver
Cozzo Presepe	S	1	u2	19	0.0	10.5	21.1	21.1	21.1	15.8	10.5	0.0	Payne
San Giovanni	S	2	r	13	0.0	7.7	30.8	23.1	23.1	7.7	7.7	0.0	Grant/Payne
San Giovanni	S	3	r	518	1.0	10.8	11.4	10.4	25.1	20.5	13.7	7.1	Grant/Payne
Matrice	C	1	r	17	0.0	5.9	15.8	58.8	0.0	11.8	5.9	0.0	Payne (1973)
Pompeii, Ganimede	C	1	u1	19	0.0	5.3	36.8	0.0	15.8	21.1	21.1	0.0	Silver (MNI)
Populonia	C	1	u1	na	0.0	5.2	24.5	11.6	17.3	31.4	10.1	0.0	Payne (1973)
Via Gabina, site 11	C	1,2	r	2				50.0	50.0				Grant
Matrice	C	2	r	18	0.0	33.3	16.7	38.9	5.6	0.0	5.6	0.0	Payne (1973)
Forum Transitorium	C	2	u1/sp	10	0.0	0.0	20.0	15.0	15.0	10.0	40.0	0.0	Payne (1973)
Via Gabina, site 10	C	3	r	14	0.0	7.1	0.0	42.9	21.4	21.4	7.1	0.0	Grant
Matrice	C	3	r	53	0.0	7.5	20.8	56.6	9.4	3.8	1.9	0.0	Payne (1973)
San Giacomo	C	3	r	4					25.0	50.0	25.0		Grant/Payne
Lugnano, cemetery	C	3	sp	19	0.0	0.0	10.5	21.1	21.1	10.5	31.6	5.3	Grant/Payne
Carminiello	C	3	u1	83	0.0	1.2	7.8	16.3	15.7	30.1	15.7	13.3	Grant/Payne
Schola Praeconum	C	3	u1	48	0.0	0.0	0.0	0.0	16.7	56.3	27.1	0.0	Silver
Settefinestre	C	1,2,3	r	15	0.0	13.3	0.0	33.3	6.7	6.7	26.7	13.3	Grant/Payne
Montereale	N	1	sp	13	0.0	15.4	0.0	7.7	15.4	7.7	53.8	0.0	Payne
Colognola	N	1	u2	31	0.0	3.2	25.8	22.6	29.0	12.9	6.5	0.0	Silver (MNI)
Pozzuolo	N	1	u2	4		25.0			25.0	25.0			Silver
Modena	N	2	u1	na	0.0	0.0	20.6	31.0	3.7	25.2	13.3	5.9	Payne (1973)
Stufels - Hotel	N	2	u2	26	0.0	11.5	26.9	7.7	26.9	11.5	15.4	0.0	Silver
Stufels - Senoner	N	2	u2	15	0.0	20.0	0.0	20.0	40.0	13.3	6.7	0.0	Silver
Innichen	N	2	u2	11	0.0	27.3	9.1	18.2	36.4	9.1	0.0	0.0	Silver
Monte Barro	N	3	r	23	0.0	34.7	21.7	43.4	0.0	0.0	0.0	0.0	Silver
Lomello	N	3	r	7			28.6	28.6			28.6	14.3	Payne (1973)
Altino	N	3	u1	14	0.0	7.1	7.1	14.3	50.0	21.4	0.0	0.0	Silver
Otranto	N	3	u1	3			66.7		33.3				Silver
Volano	N	2,3	sp	4		25.0			75.0				Silver
Invillino	N	2,3	u2	175	0.0	4.6	24.0	25.1	29.1	15.4	1.7	0.0	Silver

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial ; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Technique: Grant=using wear stages proposed by Grant (1982); Payne=using wear stages proposed by Payne (1987); Payne (1973)=using the stages and criteria outlined in Payne (1973); Silver=using dental eruption criteria of Silver (1969)

Appendix 8

Frequency of sheep/goat in various age categories for individual sites.

Sites are arranged according to geographic region, time period, and site type.

SITE	R	P	T	Aging Criterion	sample size for age categories	Age category						Notes
						fetal	neonate	juvenile	subadult	adult	old age	
Roccagloriosa, votive	S	1	sp	na	na				all			
Kaulonia	S	1	u1	na	324			4.3	14.8	80.1		
Metaponto, Pizz.	S	1	u2	na	6					100		
Roccagloriosa	S	1	u2	na	na		0.5	9.7	24.4	60.8	4.6	
San Giovenale	C	1	r	na	20				10	90		
San Giovenale, cult	C	1	sp	na	2				50	50		
Pompeii 94	C	1	u1	na	na				most			
San Omobono	C	1	u1/sp	na	141	11.3	65.2	10.6	4.3	8.5		MNI
Monte Gelato	C	2	r	na	na					c.67		
Le Colonne	C	2	r	na	na					most		
Monte Gelato	C	3	r	na	na					c.67		
Rome, Meta Sudans	C	3	u1	na	22			13.6	36.4	50		MNI
Pistoia	C	23	u1	na	na				some	most		
Spina	N	1	u1	na	na					c.60		
Pozzuolo del Friuli	N	1	u2	na	na				some	most		
Palazzo Dugentesco	N	2	u2	na	na					most		
Lomello	N	3	r	na	na		none	present	present			
Udine	N	3	u2	na	na			23.1	23.1	53.8		MNI

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
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T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

Appendix 9

Pig: Fusion data for individual sites.

Figures indicate the mean frequency of pigs younger than the specific age category. Sites are arranged according to geographic region, time period, and site type. The elements comprising each fusion age category are listed in Appendix 19.

Site	R	P	T	fusion sample size	Fusion age category		
					7-11 months	19-23 months	31-35+ months
Gravina (2nd BC-1st AD)	S	1	r	66	27.8	54.2	70.8
Gravina, pit	S	1	r	13	0.0	20.0	100.0
Gravina (7th-mid 2nd BC)	S	1	r	12	25.0	50.0	75.0
Monte Irsi (1st BC)	S	1	r	6	0.0	33.3	50.0
Monte Irsi (3rd-2nd BC)	S	1	r	4	0.0	100.0	
Vaste (Hellenistic)	S	1	r/sp	50	33.3	85.7	100.0
Vaste (Republican)	S	1	r/sp	6	100.0		100.0
Cozzo Presepe	S	1	u2	24	50.0	38.5	100.0
San Giovanni	S	2	r	17	83.3	33.3	100.0
San Giovanni	S	3	r	660	51.9	76.7	92.1
Otranto	S	3	u1	24	28.6	75.0	100.0
Settefinestre	C	1	r	8	100.0	100.0	
Populonia	C	1	u1	337	35.8	34.1	68.9
Settefinestre	C	2	r	144	35.1	66.7	93.8
Matrice (2nd-3rd AD)	C	2	r	68	76.2	87.1	100.0
Quintili	C	2	r	44	50.0	26.7	16.7
Matrice (1st AD)	C	2	r	12	33.3	55.6	
Lugnano, villa	C	2	r	6	0.0	0.0	
Forum Transitorium	C	2	u1	26	20.0	68.8	100.0
Luni	C	2	u1	10	0.0	66.7	
Via Gabina, site 10	C	3	r	213	85.1	80.3	96.8
Settefinestre	C	3	r	74	30.4	51.5	72.2
Matrice	C	3	r	66	65.0	76.7	87.5
San Giacomo	C	3	r	11	75.0	100.0	100.0
Lugnano, villa	C	3	r	2		0.0	
Lugnano, cemetery	C	3	sp	78	68.2	84.4	95.6
Campochiaro	C	3	sp	19	66.7	54.5	80.0
Carminiello	C	3	u1	199	19.2	70.2	84.8
Schola Praeconum	C	3	u1	143	12.2	66.2	91.9
Naples, Girolamini	C	3	u1	75	74.4	92.3	95.7
Luni	C	3	u1	36	0.0	48.0	66.7
Naples, S. Patrizia	C	3	u1	28	40.0	100.0	50.0
Naples, Via San Paolo	C	3	u1	11	40.0	100.0	100.0
Via Gabina, site 11	C	1,2	r	8	50.0	66.7	
Carminiello	C	1,2	u1	70	10.7	77.8	91.7
Montereale	N	1	sp	183	61.8	65.1	94.4
Modena	N	2	u1	208	26.4	85.7	94.9
Monte Barro	N	3	r	146	36.8	72.6	91.4

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
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T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 10

Frequency of pig teeth in dental age classes at individual sites.
Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	Sample size	Dental age category									Notes	Technique
					fetal/ newborn	1-3 months	3-6 months	6-12 months	12-15 months	16-18 months	18-24 months	24+ months	30+ months		
Gravina	S	1	r	30	6.7	6.7	6.7	16.7	6.7	13.3	13.3	16.7	13.3		Grant
Monte Irsi	S	1	r	10	0.0	0.0	10.0	10.0	50.0	0.0	20.0	10.0	0.0		Silver
Locri	S	1	sp	8	0.0	0.0	12.5	12.5	0.0	0.0	62.5	0.0	12.5		Silver
Vaste (Hellenistic)	S	1	sp	4	0.0	0.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0		Bull and Payne, Grant
Vaste (Republican)	S	1	sp	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0		Bull and Payne, Grant
San Giovanni	S	2	r	17	0.0	0.0	5.9	23.5	17.6	23.5	17.6	0.0	11.8	A	Grant/stage (NISP)
San Giovanni	S	3	r	2253	0.1	0.8	3.7	11.3	12.6	30.0	28.7	0.0	12.7	A	Grant/stage (NISP)
Otranto	S	3	u1	14	0.0	0.0	14.3	42.9	0.0	0.0	14.3	28.6	0.0		Grant (NISP)
Matrice	C	1	r	10	0.0	0.0	0.0	50.0	0.0	0.0	50.0	0.0	0.0		Grant
Narce	C	1	r	2	0.0	0.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0		Silver
Populonia	C	1	u1	38	0.0	0.0	44.7	5.3	2.6	26.3	0.0	21.1	0.0		Silver (MNI)
Pompeii, Ganimede	C	1	u1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0		Silver
Cozzo Presepe	C	1	u2	18	0.0	0.0	16.7	38.9	16.7	0.0	22.2	5.6	0.0		Grant
Via Gabina, site 11	C	1,2	r	5	0.0	0.0	20.0	0.0	20.0	20.0	40.0	0.0	0.0		Grant (NISP)
Matrice	C	2	r	6	0.0	0.0	33.3	16.7	33.3	0.0	16.7	0.0	0.0		Grant
Forum Transitorium	C	2	u1	11	0.0	0.0	18.2	0.0	27.3	0.0	36.4	9.1	9.1		Bull and Payne
Via Gabina, site 10	C	3	r	52	9.6	1.9	7.7	17.3	11.5	5.8	30.8	13.5	1.9		Grant (NISP)
Matrice	C	3	r	4	0.0	0.0	25.0	25.0	25.0	0.0	25.0	0.0	0.0		Grant
San Giacomo	C	3	r	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0		Grant
Lugnano, cemetery	C	3	sp	92	3.3	2.2	5.4	13.0	17.4	15.2	28.3	0.0	15.2	A	Grant/stage (NISP)
Carminiello	C	3	u1	68	0.0	0.0	25.0	16.2	0.0	0.0	10.3	22.1	26.5	B, D	Bull and Payne, Grant
Schola Praeconum	C	3	u1	56	0.0	0.0	0.0	1.8	0.0	10.7	0.0	42.9	44.6		Silver
Settefinestre	C	1,2,3	r	38	0.0	0.0	27.6	6.6	2.9	7.3	2.9	28.9	23.7	B	Grant
Montereale	N	1	sp	28	0.0	0.0	14.3	28.6	3.6	0.0	25.0	14.3	14.3	B	Bull and Payne (MNI)
Colognola	N	1	u2	30	0.0	0.0	16.6	20.0	3.3	16.7	20.0	13.3	10.0		Silver (MNI)
Pozzuolo del Friuli	N	1	u2	5	0.0	0.0	40.0	0.0	0.0	0.0	40.0	20.0	0.0		Silver
Modena	N	2	u1	18	0.0	0.0	11.1	16.7	16.7	16.7	11.1	0.0	27.8		Bull and Payne (MNI)
Stufels - Hotel	N	2	u2	16	0.0	0.0	31.3	0.0	6.3	0.0	18.8	31.3	12.5		Silver
Stufels - Senoner	N	2	u2	9	0.0	0.0	33.3	11.1	0.0	11.1	11.1	22.2	11.1		Silver
Innichen	N	2	u2	7	0.0	0.0	42.9	0.0	0.0	0.0	42.9	14.3	0.0		Silver
Invillino	N	2,3	u2	137	0.0	0.0	13.9	8.7	0.0	22.6	13.1	27.0	14.6		Silver
Volano	N	2,3	sp	3	0.0	0.0	0.0	0.0	0.0	33.3	66.7	0.0	0.0		Silver
Monte Barro	N	3	r	9	0.0	0.0	55.6	22.2	0.0	11.1	0.0	11.1	0.0		Silver
Altino	N	3	u1	16	0.0	0.0	6.3	12.6	0.0	12.5	18.8	37.5	12.6		Silver

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial ; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Technique: Bull and Payne=using criteria outlined by Bull and Payne (1988); Grant=using wear stages proposed by Grant (1982); Silver=using dental eruption criteria of Silver (1969)

A: "18-24 months" category = "18-30 months" in this case
B: "3-6 months" category = "0-6 months" in this case
D: "18-24 months" category = "13=24 months" in this case

Appendix 11

Frequency of pigs in various age categories for individual sites.

Sites are arranged according to geographic region, time period, and site type.

SITE	R	P	T	Aging Criterion	sample size for age categories	Age category						Notes
						fetal	neonate	juvenile	subadult	adult	old age	
Locri	S	1	sp	dental	9			22.2	55.6		22.2	
Kaulonia	S	1	u1	na	105			9.5	45.3	49.5		
Metaponto, Pizz.	S	1	u2	na	2					100.0		
Roccagloriosa	S	1	u2	na	na			18.5	32.4	45.4	3.7	
San Giovenale	C	1	r	na	20			15.0		85.0		
San Giovenale cult	C	1	sp	na	2			50.0		50.0		
Pompeii 94	C	1	u1	na	na				most			
Pompeii 95	C	1	u1	na	na			many	many			
Pompeii, gardens	C	1	u1	na	na			some		some		
San Omobono	C	1	u1/sp	na	73	26.0	32.9	9.6	19.2	12.3		
Le Colonne	C	2	r	na	na			few	most	some		
San Costanzo	C	2	r	na	1			100.0				
Cantone	C	2	sp	na	57		15.8	21.1	24.6	12.3	26.3	
Naples, Capua	C	2	u1	na	na			many	many			
Pistoia	C	2,3	u1	na	na				most			
Monte Gelato	C	2,3	r	na	na			c.60-70	c.30-40	c.23-36		
Rome, Meta Sudans	C	3	u1	na	85		5.7	20	42.9	31.4		MNI
Naples, Capua	C	3	u1	na	na			many	many			
Naples, Santa Maria la Nova	C	3	u1	na	na		none	none	most		none	
Spina	N	1	u1	na	na					c.30.0		
Palazzo Dugentesco	N	2	u2	na	11			27.3		72.7		
Lomello	N	3	r	na	na	1 fetal		few	few	most		
Udine	N	3	u2	na	na			46.8	23.1	30.1		
Villa Clelia	N	3	u2	na	1			100.0				MNI

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T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
na = data not available

Appendix 12

Distribution of meat weight "constants" (in kg) used at various Roman period sites in Italy.

Site	R	P	Taxon								
			cattle	sheep /goat	pig	horse	red deer	roe deer	wild boar	hare	rabbit
San Giovanni	S	1,2,3	192.5	28	63		100	30	70	5	2
Le Colonne	C	2	200	30	70						
Schola Praeconum	C	3	225	30	45	200	90				
Via San Paolo, S.Patrizia, Girolamini	C	3	226	27	45						
Carminiello	C	1,2,3	192.5	28	63						
Settefinestre	C	1,2,3	192.5	27.5	63		150				
Matrice	C	1,2,3	192.5	30.3	49.5						
Pistoia	C	2,3	275	27.5	80						
Palazzo Dugentesco	N	2	170	25	60	100					
Monte Barro	N	3	227	27	46						

R = Geographic regions: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal periods: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity

Appendix 13

Domestic and wild mammal meat weight estimates and frequencies calculated on the basis of MNI figures.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	MNI	meat weight estimate (kg)			total meat weight estimate (kg)		%	
					cattle	s/g	pig	domestic	wild	domestic	wild
Gravina, pit	S	1	r	19	192.4	280.0	188.4	660.8	88.0	88.2	11.8
Vaste (Hellenistic)	S	1	r/sp	11	192.4	56.0	376.8	625.2	0.0	100.0	0.0
Vaste (Republican)	S	1	r/sp	14	384.8	112.0	235.5	732.3	80.0	90.2	9.8
Capacci	S	1	sp	14	0.0	112.0	0.0	112.0	0.0	100.0	0.0
Gravetta	S	1	sp	28	577.2	224.0	188.4	989.6	240.0	80.5	19.5
Locri	S	1	sp	37	1346.8	392.0	376.8	2115.6	145.0	93.6	6.4
Kaulonia	S	1	u1	329	19047.6	3948.0	3297.0	26292.6	305.0	98.9	1.1
Metaponto, kiln	S	1	u2	82	4425.2	504.0	471.0	5400.2	641.0	89.4	10.6
San Giovanni	S	2	r	20	392.8	169.2	326.9	888.9	84.0	91.4	8.6
San Giovanni	S	3	r	621	3203.2	3609.6	14720.0	21532.8	589.0	97.3	2.7
Otranto	S	3	u1	17	400.4	85.2	138.0	623.6	22.0	96.6	3.4
San Giovenale	C	1	r	14	594.6	81.6	217.0	893.2	84.0	91.4	8.6
Settefinestre	C	1	r	34	991.0	217.6	260.4	1469.0	246.0	85.6	14.4
San Giovenale, cult	C	1	sp	7	198.2	54.4	86.8	339.4	80.0	80.9	19.1
San Omobono	C	1	u1/sp	177	1783.8	2992.0	2126.6	6902.4	0.0	100.0	0.0
Carminiello	C	1	u1	18	396.4	163.2	347.2	906.8	0.0	100.0	0.0
Pompeii, Ganimede	C	1	u1	41	1387.4	516.8	434.0	2338.2	145.0	94.2	5.8
Populonia	C	1	u1	93	1982.0	843.2	1866.2	4691.4	178.0	96.3	3.7
Via Gabina, site 11	C	1, 2	r	10	198.2	54.4	173.6	426.2	0.0	100.0	0.0
Le Colonne	C	2	r	33	785.6	187.2	801.6	1774.4	284.0	86.2	13.8
Lugnano, villa	C	2	r	11	196.4	93.6	150.3	440.3	178.0	71.2	28.8
Matrice (1st AD)	C	2	r	13	392.8	93.6	200.4	686.8	84.0	89.1	10.9
Matrice (2nd-3rd AD)	C	2	r	29	589.2	218.4	501.0	1308.6	142.0	90.2	9.8
Monte Gelato	C	2	r	16	196.4	93.6	250.5	540.5	80.2	87.1	12.9
Quintili	C	2	r	21	0.0	156.0	501.0	657.0	0.0	100.0	0.0
Settefinestre	C	2	r	102	2553.2	499.2	1302.6	4355.0	748.6	85.3	14.7
Cantone	C	2	sp	65	196.4	436.8	2505.0	3138.2	0.0	100.0	0.0
Capua, Carillo	C	2	u1	8	196.4	93.6	150.3	440.3	0.0	100.0	0.0
Carminiello	C	2	u1	8	196.4	62.4	150.3	409.1	0.0	100.0	0.0
Forum Transitorium	C	2	u1	10	196.4	62.4	350.7	609.5	0.0	100.0	0.0
Pistoia	C	2	u1	17	1126.8	89.1	371.2	1587.1	0.0	100.0	0.0
Lugnano, villa	C	3	r	12	195.4	61.0	239.0	495.4	4.0	99.2	0.8
Matrice	C	3	r	41	977.0	366.0	621.4	1964.4	124.0	94.1	5.9
Monte Gelato	C	3	r	23	195.4	335.5	239.0	769.9	58.0	93.0	7.0
San Giacomo	C	3	r	29	586.2	213.5	334.6	1134.3	178.0	86.4	13.6
Settefinestre	C	3	r	37	781.6	305.0	573.6	1660.2	382.0	81.3	18.7
Via Gabina, site 10	C	3	r	49	1367.8	366.0	621.4	2355.2	22.0	99.1	0.9
Lugnano, cemetery	C	3	sp	70	390.8	213.5	1290.6	1894.9	120.3	94.0	6.0
Capua, Carillo	C	3	u1	6	195.4	61.0	95.6	352.0	0.0	100.0	0.0
Carminiello	C	3	u1	120	1758.6	945.5	1195.0	3899.1	102.0	97.5	2.5
Naples, Girolamini	C	3	u1	23	390.8	213.5	525.8	1130.1	40.0	96.6	3.4
Naples, S. Patrizia	C	3	u1	19	390.8	152.5	334.6	877.9	4.0	99.5	0.5
Naples, Santa Maria la Nova	C	3	u1	7	195.4	61.0	47.8	304.2	58.0	84.0	16.0
Naples, Via San Paolo	C	3	u1	35	1563.2	274.5	573.6	2411.3	0.0	100.0	0.0
Pistoia	C	3	u1	89	4425.2	602.6	1779.7	6807.5	210.0	97.0	3.0
Rome, Meta Sudans	C	3	u1	87	4689.6	671.0	1673.0	7034.0	312.0	95.8	4.2
Schola Praeconum	C	3	u1	53	1172.4	518.5	1147.2	2838.1	80.0	97.3	2.7
Montereale	N	1	sp	44	178.0	334.1	1338.4	1850.0	4.0	99.8	0.2
Colognola	N	1	u2	101	2848.0	821.5	1440.0	5109.5	870.0	85.5	14.5
Pozzuolo del Friuli	N	1	u2	20	1068.0	159.0	288.0	1515.0	145.0	91.3	8.7
Volano	N	2	sp	12	939.0	59.4	92.8	1091.2	0.0	100.0	0.0
Modena	N	2	u1	75	1314.6	1039.5	1299.2	3653.3	40.0	98.9	1.1
Innichen	N	2	u2	32	1126.8	326.7	324.8	1778.3	149.0	92.3	7.7
Stufels - Hotel	N	2	u2	61	2253.6	772.2	742.4	3768.2	164.0	95.8	4.2
Stufels - Senoner	N	2	u2	51	2441.4	504.9	649.6	3595.9	283.0	92.7	7.3
Torcello	N	2	u2	34	1502.4	386.1	556.8	2445.3	18.0	99.3	0.7
Volano	N	3	sp	15	1731.6	52.4	48.1	1832.1	0.0	100.0	0.0
Altino	N	3	u1	43	1539.2	366.8	769.6	2675.6	0.0	100.0	0.0
Villa Clelia	N	3	u2	4	384.8	26.2	48.1	459.1	0.0	100.0	0.0

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 14

Meat weight frequencies for cattle, sheep/goat, and pig calculated on the basis of NISP frequencies and using meat weight contants presented in Table 52.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	NISP*	% of total domestic meat		
					cattle	sheep/goat	pig
Gravina (7th-2nd BC)	S	1	r	97	61.2	23.0	15.8
Gravina (2nd BC-1st AD)	S	1	r	555	61.7	24.3	14.0
Gravina, pit	S	1	r	290	12.6	56.3	31.0
Monte Irsi (1st BC)	S	1	r	44	69.8	9.5	20.8
Monte Irsi (3rd-2nd BC)	S	1	r	113	82.7	7.2	10.1
Vaste (Hellenistic)	S	1	r/sp	147	5.5	0.8	93.7
Vaste (Republican)	S	1	r/sp	45	24.5	11.8	63.7
Capacci	S	1	sp	18	0.0	100.0	0.0
Gravetta	S	1	sp	48	81.9	11.4	6.7
Locri	S	1	sp	374	70.2	13.1	16.7
Naniglio	S	1	sp	0	0.0	0.0	0.0
Roccagloriosa, votive	S	1	sp	62	0.0	97.3	2.7
Hipponion-Vibo Valentia	S	1	sp	0	0.0	0.0	0.0
Otranto	S	1	u1	228	78.3	13.8	7.9
Kaulonia	S	1	u1	716	71.9	19.4	8.8
Metaponto, kiln	S	1	u2	324	88.2	6.9	4.8
Metaponto, Pizz.	S	1	u2	218	89.8	4.1	6.1
Cozzo Presepe	S	1	u2	281	53.6	33.0	13.4
Roccagloriosa	S	1	u2	1698	76.6	14.8	8.6
San Biago	S	2	r	231	36.3	28.6	35.1
San Giovanni	S	2	r	158	34.3	10.5	55.2
San Giovanni	S	3	r	10059	24.8	9.1	66.1
Otranto	S	3	u1	361	78.1	10.0	11.9
Narce	C	1	r	77	64.1	22.7	13.3
San Giovenale	C	1	r	47	37.4	11.3	51.3
Settefinestre	C	1	r	175	40.4	21.8	37.8
San Giovenale, cult	C	1	sp	36	54.9	25.0	20.1
San Omobono	C	1	u1/sp	2042	28.4	40.3	31.3
Carminiello	C	1	u1	234	21.5	16.1	62.4
Ostia, castrum	C	1	u1	104	37.3	0.8	61.8
Pompeii 95	C	1	u1	147	16.2	29.4	54.4
Pompeii, Forum	C	1	u1	2570	55.8	9.0	35.2
Pompeii, Ganimede	C	1	u1	903	73.8	14.4	11.8
Populonia	C	1	u1	1988	38.9	22.3	38.8
Via Gabina, site 11	C	1,2	r	76	35.4	11.8	52.7
Le Colonne	C	2	r	508	57.1	11.5	31.3
Lugnano, villa	C	2	r	21	42.2	11.2	46.6
Matrice (1st AD)	C	2	r	262	55.3	13.9	30.8
Matrice (2nd-3rd AD)	C	2	r	394	32.3	16.1	51.6
Monte Gelato	C	2	r	294	23.9	12.2	63.9
Quintili	C	2	r	132	0.0	8.9	91.1
San Costanzo	C	2	r	28	0.0	14.5	85.5
San Potito	C	2	r	239	60.0	9.2	30.8
Settefinestre	C	2	r	2237	33.8	8.3	57.9
Cantone	C	2	sp	824	2.6	22.6	74.7
Capua, Carillo	C	2	u1	44	24.5	16.9	58.5
Carminiello	C	2	u1	103	8.0	22.9	69.1
Forum Transitor.	C	2	u1	72	36.9	4.6	58.6
Naples, Santa Sofia	C	2	u1	46	55.4	10.6	34.0
Ostia, bath	C	2	u1	2519	34.1	17.6	48.3
Ostia, castrum	C	2	u1	120	3.4	18.6	77.9
Pompeii, Forum	C	2	u1	502	34.4	14.0	51.6
Pompeii, gardens	C	2	u1	188	68.7	8.6	22.7
Saepinum	C	2	u1	39	47.3	22.5	30.2
Cosa	C	2	u1	14	89.3	3.2	7.6
Luni	C	2	u1	106	73.5	7.3	19.2
Pistoia	C	2	u1	25	74.4	3.5	22.1
Lugnano, villa	C	3	r	27	35.9	11.2	52.9
Matrice	C	3	r	816	37.9	20.3	41.9
Monte Gelato	C	3	r	463	22.0	22.3	55.8
San Giacomo	C	3	r	205	48.6	27.2	24.2

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
* total NISPof principal domestic mammals only (i.e., NISP cattle + NISP sheep/goat + NISP pig)

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Appendix 14 (continued)

Meat weight frequencies for cattle, sheep/goat, and pig calculated on the basis of NISP frequencies and using meat weight contants presented in Table 52.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	NISP*	% of total domestic meat		
					cattle	sheep/goat	pig
Settefinestre	C	3	r	757	48.4	14.0	37.6
Via Gabina, site 10	C	3	r	1266	43.8	14.3	41.9
Lugnano, cemetery	C	3	sp	405	36.8	9.8	53.4
Campochiaro	C	3	sp	593	53.4	16.1	30.4
Capua, Carillo	C	3	u1	40	38.6	8.4	53.0
Carminiello	C	3	u1	2087	32.9	32.6	34.5
Naples, Girolamini	C	3	u1	734	25.4	21.0	53.6
Naples, S. Patrizia	C	3	u1	547	6.7	12.8	80.6
Naples, Santa Maria la Nova	C	3	u1	70	33.7	14.3	52.0
Naples, Via San Paolo	C	3	u1	164	51.7	14.5	33.8
Ostia, bath	C	3	u1	147	38.3	10.0	51.7
Schola Praeconum	C	3	u1	1568	34.6	18.1	47.4
Rome, Meta Sudans	C	3	u1	1852	51.8	11.3	36.9
Pistoia	C	3	u1	131	69.3	6.1	24.7
Luni	C	3	u1	539	57.0	16.3	26.7
Montreale	N	1	sp	1163	2.3	31.7	66.0
Spina	N	1	u1	na	56.0	6.2	37.8
Colognola	N	1	u2	1829	74.0	7.6	18.4
Pozzuolo del Friuli	N	1	u2	267	87.9	5.5	6.6
Aquileia	N	2	sp	601	100.0	0.0	0.0
Volano	N	2	sp	91	98.7	0.7	0.6
Modena	N	2	u1	1309	37.8	21.1	41.1
Innichen	N	2	u2	721	53.3	39.0	7.7
Palazzo Dugentesco	N	2	u2	43	57.6	20.2	22.2
Stufels - Hotel	N	2	u2	1128	68.2	16.8	14.9
Stufels - Senoner	N	2	u2	1506	63.5	20.2	16.3
Torcello	N	2	u2	75	55.6	18.8	25.6
Invillino	N	2.3	u2	4703	54.6	20.6	24.8
Invillino TOTAL	N	2.3	u2	21642	64.3	15.5	20.2
Lomello	N	3	r	253	66.7	11.1	22.2
Monte Barro	N	3	r	1290	37.0	13.1	49.9
Volano	N	3	sp	208	99.4	0.2	0.4
Altino	N	3	u2	722	77.9	4.6	17.5
Invillino	N	3	u2	3325	67.6	13.3	19.1
Udine	N	3	u2	1056	68.2	12.4	19.4
Villa Clelia	N	3	u2	25	95.1	1.3	3.6

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
* total NISPof principal domestic mammals only (i.e., NISP cattle + NISP sheep/goat + NISP pig)

Appendix 15

Meat weight frequencies for cattle, sheep/goat, and pig calculated on the basis of MNI values and using meat weight contants presented in Table 52.

Sites are arranged according to geographic region, time period, and site type.

Site	R	P	T	MNI*	% of total domestic meat		
					cattle	sheep/goat	pig
Gravina, pit	S	1	r	15	29.2	42.4	28.5
Vaste (Hellenistic)	S	1	r/sp	11	32.2	4.7	63.1
Vaste (Republican)	S	1	r/sp	11	58.5	12.8	28.7
Capacci	S	1	sp	4	0.0	100.0	0.0
Gravella	S	1	sp	15	58.3	22.7	19.1
Locri	S	1	sp	29	63.6	18.6	17.8
Kaulonia	S	1	u1	310	72.4	15.1	12.6
Metaponto, kiln	S	1	u2	51	81.9	9.4	8.7
San Giovanni	S	2	r	15	44.1	19.1	36.8
San Giovanni	S	3	r	464	14.7	16.9	68.4
Otranto	S	3	u1	8	64.2	13.7	22.1
San Giovenale	C	1	r	11	66.5	9.1	24.4
Settefinestre	C	1	r	19	67.4	14.8	17.8
San Giovenale, cult	C	1	sp	5	58.3	16.0	25.7
Carminiello	C	1	u1	16	43.6	17.9	38.4
Pompeii 94	C	1	u1	na	68.7	5.5	25.8
Pompeii, Ganimede	C	1	u1	36	59.2	22.1	18.7
Populonia	C	1	u1	84	42.2	17.9	39.9
San Omobono	C	1	u1/sp	168	26.0	43.1	30.9
Via Gabina, site 11	C	1,2	r	7	44.6	13.2	42.3
Le Colonne	C	2	r	26	44.3	10.6	45.1
Lugnano, villa	C	2	r	7	44.4	21.3	34.2
Matrice (1st AD)	C	2	r	9	57.2	13.6	29.2
Matrice (2nd-3rd AD)	C	2	r	20	45.0	16.7	38.3
Monte Gelato	C	2	r	9	36.3	17.3	46.3
Quintili	C	2	r	15	0.0	23.7	76.3
Settefinestre	C	2	r	55	58.6	11.5	29.9
Cantone	C	2	sp	65	6.1	13.9	79.9
Capua, Carillo	C	2	u1	7	44.6	21.3	34.1
Carminiello	C	2	u1	6	48.1	15.2	36.7
Forum Transitororium	C	2	u1	10	32.2	10.2	57.5
Lugnano, villa	C	3	r	8	39.4	12.3	48.3
Matrice	C	3	r	30	49.8	18.6	31.6
Monte Gelato	C	3	r	17	25.4	43.5	31.1
San Giacomo	C	3	r	17	51.6	18.8	29.6
Settefinestre	C	3	r	26	47.1	18.4	34.5
Via Gabina, site 10	C	3	r	32	58.1	15.5	26.4
Campochiaro	C	3	sp	28	70.5	12.2	17.3
Lugnano, cemetery	C	3	sp	36	20.7	11.2	68.1
Capua, Carillo	C	3	u1	5	55.5	17.3	27.2
Carminiello	C	3	u1	65	44.8	24.1	31.1
Naples, Girolamini	C	3	u1	20	34.6	18.9	46.6
Naples, S. Patrizia	C	3	u1	14	44.3	17.4	38.3
Naples, Santa Maria la Nova	C	3	u1	4	60.8	9.5	29.8
Naples, Via San Paolo	C	3	u1	29	64.8	11.4	23.8
Rome, Meta Sudans	C	3	u1	72	66.7	9.5	23.8
Schola Praeconum	C	3	u1	47	41.3	18.2	40.4
Montereale	N	1	sp	44	9.6	18.1	72.3
Colognola	N	1	u2	77	55.7	16.1	28.2
Pozzuolo del Friuli	N	1	u2	17	71.7	8.9	19.4
Volano	N	2	sp	9	86.1	5.4	8.5
Modena	N	2	u1	70	36.0	28.4	35.6
Pistoia	N	2	u1	17	71.0	5.6	23.4
Innichen	N	2	u2	24	63.4	18.3	18.3
Stufels - Hotel	N	2	u2	54	59.8	20.5	19.7
Stufels - Senoner	N	2	u2	44	67.9	14.0	18.1
Torcello	N	2	u2	33	61.4	15.8	22.8
Monte Barro	N	3	r	27	45.8	14.0	40.2
Volano	N	3	sp	12	94.5	2.9	2.6
Altino	N	3	u1	38	57.6	13.7	28.7
Pistoia	N	3	u1	83	73.1	6.6	20.3
Udine	N	3	u2	na	59.1	16.8	24.1
Villa Clelia	N	3	u2	4	83.8	5.7	10.5

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special
* total MNI of principal domestic mammals only (i.e., MNI cattle + MNI sheep/goat + MNI pig)

Appendix 16

NISP frequency of cattle body parts by skeletal part category at individual sites.

Sites are arranged according to geographic area, time period, and site type.

Site	R	P	T	cattle NISP	Skeletal part category			
					%head	%primary	%secondary	%extremity
Monte Irsi (3rd-2nd BC)	S	1	r	30	10.0	30.0	30.0	30.0
Monte Irsi (1st BC)	S	1	r	15	0.0	20.0	46.7	33.3
Gravina (2nd BC-1st AD)	S	1	r	135	2.2	17.8	14.8	65.2
Gravina (7th-2nd BC)	S	1	r	21	0.0	23.8	19.0	57.1
Gravina, pit	S	1	r	6	20.0	20.0	20.0	40.0
Locri	S	1	sp	125	27.7	12.9	17.8	41.6
Gravetta	S	1	sp	21	31.6	21.1	15.8	31.6
Cozzo Presepe	S	1	u2	42	2.4	21.4	7.1	69.0
San Giovanni	S	2	r	24	13.0	0.0	26.1	60.9
San Giovanni	S	3	r	689	32.6	13.4	11.7	42.3
Otranto	S	3	u1	141	63.8	13.5	9.2	13.5
Narce	C	1	r	9	55.6	11.1	11.1	22.2
San Giovenale	C	1	r	5	60.0	20.0	0.0	20.0
San Giovenale, cult	C	1	sp	4	25.0	25.0	25.0	25.0
Pompeii, Ganimede	C	1	u1	286	48.9	18.2	6.3	25.0
Pompeii, gardens	C	1	u1	63	19.3	14.0	1.8	64.9
Populonia	C	1	u1	205	25.3	20.2	10.1	44.4
Via Gabina, site 11	C	1,2	r	8	25.0	37.5	25.0	12.5
Settefinestre	C	2	r	271	36.2	18.5	12.5	32.8
Matrice	C	2	r	76	36.8	17.1	23.7	22.4
Lugnano, villa	C	2	r	3	0.0	0.0	33.3	66.7
Luni	C	2	r	36	22.2	19.4	13.9	44.4
Forum Transitorium	C	2	u1	9	11.1	33.3	11.1	44.4
Saepinum	C	2	u1	6	66.7	0.0	0.0	33.3
Via Gabina, site 10	C	3	r	152	29.7	24.3	10.8	35.1
Settefinestre	C	3	r	110	33.6	22.7	11.8	31.8
Matrice	C	3	r	85	38.8	29.4	11.8	20.0
San Giacomo	C	3	r	25	41.7	12.5	29.2	16.7
Lugnano. villa	C	3	r	3	66.7	33.3	0.0	0.0
Luni	C	3	r	98	19.4	28.6	32.7	19.4
Campochiaro	C	3	sp	113	68.9	18.4	7.8	4.9
Lugnano, cemetery	C	3	sp	56	53.7	24.1	3.7	18.5
Carminiello	C	3	u1	147	10.2	27.9	29.9	32.0
Schola Praeconum	C	3	u1	112	14.3	25.0	21.4	39.3
Naples, Girolamini	C	3	u1	49	32.7	36.7	2.0	28.6
Naples, Via San Paolo	C	3	u1	29	35.7	28.6	17.9	17.9
Naples, S. Patrizia	C	3	u1	10	0.0	62.5	0.0	37.5
Colognola	N	1	u2	676	35.0	21.5	10.2	33.3
Pozzuolo del Friuli	N	1	u2	151	37.1	40.0	5.0	17.9
Volano	N	2	sp	84	12.3	21.9	19.2	46.6
Modena	N	2	u1	182	44.1	20.5	9.4	26.0
Stufels - Senoner	N	2	u2	364	38.3	8.3	7.3	46.1
Stufels - Hotel	N	2	u2	304	57.9	10.0	4.3	27.8
Innichen	N	2	u2	116	52.4	13.1	8.3	26.2
Torcello	N	2	u2	15	18.2	9.1	9.1	63.6
Invillino	N	2.3	u2	5373	26.6	30.0	19.5	23.8
Monte Barro	N	3	r	133	42.4	17.4	14.1	26.1
Lomello	N	3	r	71	53.6	14.5	15.9	15.9
Volano	N	3	sp	202	37.8	23.8	20.2	18.1
Altino	N	3	u1	300	25.5	35.4	7.5	31.7
Villa Clelia	N	3	u2	18	61.5	7.7	7.7	23.1

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 17

NISP frequency of sheep/goat body parts by skeletal part category at individual sites.

Sites are arranged according to geographic area, time period, and site type.

Site	R	P	T	sheep/goat NISP	Skeletal part category			
					%head	%primary	%secondary	%extremity
Gravina (2nd BC-1st AD)	S	1	r	383	31.1	17.5	19.6	31.9
Gravina, pit	S	1	r	200	27.5	15.5	17.5	39.5
Gravina (7th-2nd BC)	S	1	r	87	48.3	20.7	18.4	12.6
Monte Irsi (3rd-2nd BC)	S	1	r	54	18.5	20.4	37.0	24.1
Monte Irsi (1st BC)	S	1	r	15	13.3	20.0	40.0	26.7
Locri	S	1	sp	118	40.7	23.7	19.5	16.1
Gravella	S	1	sp	22	63.6	9.1	9.1	18.2
Capacci	S	1	sp	16	25.0	37.5	18.8	18.8
Cozzo Presepe	S	1	u2	249	12.0	11.6	27.3	49.0
San Giovanni	S	2	r	41	70.7	0.0	4.9	24.4
San Giovanni	S	3	r	2242	70.5	7.0	11.3	11.2
Otranto	S	3	u1	108	20.4	18.5	22.2	38.9
Settefinestre	C	1	r	69	50.7	15.9	11.6	21.7
Narce	C	1	r	28	39.3	17.9	21.4	21.4
San Giovenale	C	1	r	11	63.6	0.0	9.1	27.3
San Giovenale, cult	C	1	sp	24	62.5	25.0	8.3	4.2
Carminiello	C	1	u1	30	40.0	20.0	30.0	10.0
Pompeii, Ganimede	C	1	u1	214	51.4	22.0	12.1	14.5
Pompeii, gardens	C	1	u1	27	33.3	14.8	18.5	33.3
Populonia	C	1	u2	803	22.0	25.9	24.9	27.1
Via Gabina, site 11	C	1,2	r	18	33.3	5.6	11.1	50.0
Settefinestre	C	2	r	344	43.9	18.3	21.5	16.3
Matrice	C	2	r	200	31.5	27.0	29.5	12.0
Monte Gelato	C	2	r	62	41.9	29.0	16.1	12.9
Luni	C	2	r	25	12.0	48.0	20.0	20.0
San Costanzo	C	2	r	6	100.0	0.0	0.0	0.0
Lugnano, villa	C	2	r	4	0.0	25.0	50.0	25.0
Carminiello	C	2	u1	30	26.7	36.7	23.3	13.3
Saepinum	C	2	u1	17	23.5	47.1	17.6	11.8
Forum Transitorium	C	2	u1	6	50.0	33.3	0.0	16.7
Via Gabina, site 10	C	3	r	365	25.5	20.3	21.4	32.9
Matrice	C	3	r	299	36.5	22.7	21.7	19.1
Settefinestre	C	3	r	217	53.0	16.6	15.7	14.7
Monte Gelato	C	3	r	168	38.1	19.0	20.2	22.6
San Giacomo	C	3	r	106	56.6	13.2	16.0	14.2
Lugnano, villa	C	3	r	7	57.1	0.0	14.3	28.6
Luni	C	3	r	185	23.8	36.2	29.7	10.3
Lugnano, cemetery	C	3	sp	81	66.7	1.2	11.1	21.0
Carminiello	C	3	u1	983	38.5	24.1	17.7	19.7
Schola Praeconum	C	3	u1	545	36.5	34.1	13.9	15.4
Naples, Girolamini	C	3	u1	252	50.2	19.1	10.8	20.3
Naples, S. Patrizia	C	3	u1	104	54.8	12.5	10.6	22.1
Naples, Via San Paolo	C	3	u1	53	32.1	28.3	22.6	17.0
Montereale	N	1	sp	360	19.2	31.7	12.2	36.9
Colognola	N	1	u2	332	67.2	6.6	13.3	13.0
Pozzuolo del Friuli	N	1	u2	62	46.8	6.5	22.6	24.2
Volano	N	2	sp	2	50.0	0.0	0.0	50.0
Modena	N	2	u1	499	37.9	11.8	7.6	42.7
Stufels - Senoner	N	2	u2	419	24.1	24.3	11.0	40.6
Stufels - Hotel	N	2	u2	406	54.2	8.4	8.1	29.3
Innichen	N	2	u2	261	29.5	24.9	11.9	33.7
Torcello	N	2	u2	32	90.6	0.0	3.1	6.3
Invillino	N	2,3	u2	8774	43.8	19.5	24.3	12.3
Monte Barro	N	3	r	295	38.3	18.6	15.9	27.1
Lomello	N	3	r	84	73.8	8.3	6.0	11.9
Volano	N	3	sp	2	100.0	0.0	0.0	0.0
Altino	N	3	u1	93	37.6	5.4	11.8	45.2

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

2

Appendix 18

NISP frequency of pig body parts by skeletal part category at individual sites.

Sites are arranged according to geographic area, time period, and site type.

Site	R	P	T	pig NISP	Skeletal part category			
					%head	%primary	%secondary	%extremity
Gravina (2nd BC-1st AD)	S	1	r	149	47.7	10.7	19.5	22.1
Gravina, pit	S	1	r	68	45.6	8.8	5.9	39.7
Gravina (7th-2nd BC)	S	1	r	29	34.5	10.3	27.6	27.6
Monte Irsi (3rd-2nd BC)	S	1	r	24	41.7	12.5	16.7	29.2
Monte Irsi (1st BC)	S	1	r	17	35.3	29.4	17.6	17.6
Vaste	S	1	r/sp	32	56.3	12.5	15.6	15.6
Locri	S	1	sp	111	53.2	10.8	22.5	13.5
Gravetta	S	1	sp	7	100.0	0.0	0.0	0.0
Cozzo Presepe	S	1	u2	67	17.9	7.5	22.4	52.2
San Giovanni	S	2	r	126	56.3	10.3	7.1	26.2
San Giovanni	S	3	r	10181	85.5	5.1	3.2	6.2
Otranto	S	3	u1	90	47.8	16.7	13.3	22.2
Settefinestre	C	1	r	73	64.4	16.4	6.8	12.3
San Giovenale	C	1	r	31	48.4	9.7	16.1	25.8
Narce	C	1	r	7	57.1	14.3	28.6	0.0
Via Gabina, site 11	C	1,2	r	50	72.0	6.0	2.0	20.0
San Giovenale, cult	C	1	sp	19	84.2	10.5	0.0	5.3
Pompeii, Ganimede	C	1	u1	146	39.0	32.9	18.5	9.6
Pompeii, gardens	C	1	u1	73	67.1	17.8	4.1	11.0
Carminiello	C	1	u1	118	52.5	24.6	11.9	11.0
Populonia	C	1	u1	904	28.5	28.5	15.0	27.9
Settefinestre	C	2	r	1265	63.8	8.5	11.0	16.7
Matrice	C	2	r	352	46.9	23.6	15.1	14.5
Monte Gelato	C	2	r	181	53.6	15.5	10.5	20.4
San Costanzo	C	2	r	21	66.7	9.5	4.8	19.0
Lugnano, villa	C	2	r	14	35.7	7.1	14.3	42.9
Carminiello	C	2	u1	56	44.6	23.2	12.5	19.6
Forum Transitorium	C	2	u1	54	25.9	13.0	33.3	27.8
Saepinum	C	2	u1	15	33.3	13.3	26.7	26.7
Luni	C	2	u1	36	36.1	19.4	11.1	33.3
Via Gabina site 10	C	3	r	702	49.6	19.7	17.4	13.4
Matrice	C	3	r	403	50.1	23.8	16.1	9.9
Settefinestre	C	3	r	357	55.7	10.9	12.0	21.3
Monte Gelato	C	3	r	130	50.0	16.9	10.0	23.1
San Giacomo	C	3	r	62	50.0	27.4	21.0	1.6
Lugnano, villa	C	3	r	21	81.0	4.8	0.0	14.3
Lugnano, cemetery	C	3	sp	377	72.9	9.3	5.8	11.9
Campochiaro	C	3	sp	262	77.1	8.8	5.7	8.4
Schola Praeconum	C	3	u1	844	50.6	14.2	11.5	23.7
Carminiello	C	3	u1	665	53.7	20.5	13.4	12.5
Naples, S. Patrizia	C	3	u1	425	60.9	11.5	8.0	19.5
Naples, Girolamini	C	3	u1	417	52.3	22.8	14.1	10.8
Naples, Via San Paolo	C	3	u1	69	62.3	21.7	11.6	4.3
Luni	C	3	u1	180	43.3	22.2	21.1	13.3
Montereale	N	1	sp	548	55.1	21.2	6.4	17.3
Colognola	N	1	u2	577	53.6	17.9	12.3	16.3
Pozzuolo del Friuli	N	1	u2	42	66.7	21.4	11.9	0.0
Volano	N	2	sp	2	100.0	0.0	0.0	0.0
Modena	N	2	u1	632	29.6	26.7	13.0	30.7
Stufels - Senoner	N	2	u2	295	27.5	19.3	12.2	41.0
Stufels - Hotel	N	2	u2	171	58.5	7.6	8.2	25.7
Innichen	N	2	u2	34	41.2	23.5	17.6	17.6
Torcello	N	2	u2	28	39.3	28.6	10.7	21.4
Invillino	N	2,3	u2	5756	38.6	36.7	16.6	8.1
Monte Barro	N	3	r	557	48.8	19.2	11.8	20.1
Lomello	N	3	r	86	73.3	3.5	10.5	12.8
Volano	N	3	sp	3	33.3	0.0	0.0	66.7
Altino	N	3	u1	207	58.9	11.1	15.0	15.0
Villa Clelia	N	3	u2	5	40.0	20.0	0.0	20.0

R = Geographic region: S = southern Italy; C = central Italy; N = northern Italy
P = Temporal period: 1 = c. Republic; 2 = c. Imperial Period; 3 = c. Late Antiquity
T = Site type: r = rural; u1 = urban1 (i.e., city); u2 = urban2 (i.e., settlement); sp = special

Appendix 19

Elements comprising fusion age categories for:

Cattle

Fusion age category	Elements
7-10 months	scapula pelvis
12-18 months	distal humerus proximal radius phalanx 1 phalanx 2
24-36 months	distal tibia distal metapodial calcaneus
42+ months	proximal and distal femur proximal tibia proximal humerus distal radius ulna

Sheep/goat

Fusion age category	Elements
12 months	scapula pelvis distal humerus proximal radius
14-36 months	phalanx 1 phalanx 2 distal tibia proximal femur
47-48 months	distal metapodial distal femur proximal tibia
48-60 months	calcaneus distal radius proximal humerus

Pig

Fusion age category	Elements
11 months	scapula pelvis proximal radius distal humerus phalanx 2
19-23 months	distal tibia distal metapodial distal fibula phalanx 1
31-35+ months	calcaneus proximal and distal femur proximal humerus distal radius proximal tibia ulna

Based on criteria from Silver (1969).